WPG100

Potentiostat/Galvanostat

Ver. 1.2

Operation Manual

Instrument Certificate

Date: ______________

Model :	WPG
EndUser:	
AC Power Line:	100VAC-240VAC 50/60Hz
Installation date:	
Warranty Period:	One Year
Compliance voltage	
Control voltage	
Current ranges	
Serial number	

This manual has to be read carefully
Before switching on the instrument. The
Instructions must followed strictly.

Non-observance of these instructions can
Lead to the loss of right to claim for damages
Or guarantee.

WPG has been developed and
Manufactured by
WonATech Co.,Ltd
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Term

This license is effective until terminated.

If you have problems
Contact us at your earliest convenience. We can be contacted via;
E-mail: service@wonatech.com
Fax: 82-31-765-2645
Phone: 82-31-766-5974
Mail: WonATech Co.,Ltd
736-1 MoonHyungRi, OpoEup, GwangJu-Si
GyeongGi-Do, 464-894, Korea

If you write to us about a problem, provide as much informations as possible.
We need data file(rfd file), experiment schedule file (cyc or cye) and calibration data file(multi.cal in infor folder). Send them via e-mail.

Limited Warranty

WonATech warrants to the original user of this product that it shall be free of defects resulting from faulty manufacture of the product or its components for a period of one year from the date of shipment.

WonATech makes no warranties regarding either the satisfactory performance of WPG system including the software encoded in this product or the fitness of the system for any particular purpose.
The remedy for breach of this limited warranty shall be limited solely to repair or by replacement, as determined by WonATech, and shall not include other damages

WonATech reserves the right to make revisions to the system at any time without incurring any obligation to install same on systems previously purchased. All system specifications are subject to change without notice.

There are no warranties which extend beyond the description herein. This warranty is in lieu of, and excludes any and all other warranties or representations, expressed, implied including merchantability and fitness, as well as any and all other obligations, or liabilities of WonATech, including but not limited to, special or consequential damages.

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Chapter1. Pre-Startup Check

1-1.Hardware

- Don't place EMI producing unit near by this instrument (such as radio, vibration etc.).
- The cell cable itself can work as antenna. (It can receive EMI noise). Especially don't place cell cable on power line cable.
- If the result data is so noisy, make the cell cable as short as possible. (It reduce noise)
- The counter electrode is dangerous. Don't touch this electrode.
- When you turn on WPG, It is normal that potentiostat LED and galvanostat LED are lighting together. **When you execute xpciserver.exe or XUSBserver.exe then potentiostat LED is turn off.** If you executed xpciserver.exe or XUSBserver.exe and potentiostat LED is still lighting, It means that the communication between PC and WPG has a problem. In this case, check the connection of interface cable (Pull out this interface cable and try to connect it to its connector again. If this trial is faulty, then power off the PC and open the PC cover. You can find interface card in PCI slot. Pull out it and Insert it to the slot again. If the problem still remains, Please contact our service department via service@wonatech.com.) If your system is USB version, please check USB cable.

1-2. Experiment schedule file(Experiment procedure file)

- The difference between "C" cycle and "L" loop is;

  If it count cycle number (charge/discharge cycle number) then it is "C" cycle. If it does not count cycle number, it is "L" loop.
- If the 1st cycle procedure and 2nd cycle procedure is different from next cycles procedure(e.g. 1st cycle procedure: 1Amp charge, -1Amp discharge procedure and 2nd cycle procedure: 500mA charge, -500mA discharge and 3rd cycle to 100th cycles procedure: 300mA charge, -300mA discharge then You must insert "C" cycle at each step describing vertex condition(In this case, 2nd, 4th and 6th step)
- If you want cut-off condition as time from experiment starting point, please check "L" loop or "C" cycle on each step. If there is no "L" loop on each step then L-time is total time from experiment started. If there is no "C" on each step, then C-time is total time from experiment started.
- Ctime is time from each cycle start. L-time is time from each loop start.
- If you want set safety limit to protect your battery or cell from any troubled condition, make insert the condition bottom window on information tag of experiment schedule file.
- If you want C-rate charging discharging then you must insert battery capacity value on experiment schedule file.

- If your voltage or current scanning speed is fast then you must decide current range
- Load value's polarity: +value is for charging and – value is for discharge.

1-3. Potentiostat mode & Cycler mode

- Potentiostat/Galvanostat; Voltage value (for control or measurement) is based on working electrodes voltage vs. Reference electrode voltage.
- Cycler mode: Voltage value (for control or measurement) is based on positive electrode vs. Negative electrode. The connection is Positive electrode (Counter + Reference) and negative electrode (Working + working sense). So The voltage polarity is opposite in Potentiostat/galvanostat mode and cycler mode.
- If you want the control (measurement) voltage as working vs. Reference, you must select potentiostat/galvanostat mode or if you want control (measurement) voltage as counter (reference) vs. Working, you must select cycler mode.
- The main reason, which two modes are existing, came from that Commercial Potentiostat/Galvanostat is based on power supply circuit. Power supply circuit has only positive electrode and negative electrode. In this case power supply terminal is connected positive electrode and ground terminal is connected to negative electrode. But in potentiostat/Galvanostat circuit, The counter electrode is connected power supply terminal and working electrode is connected to ground terminal.
- Simply if you want WPG as potentiostat/galvanostat ,select "potentiostat mode" or if you want use WPG as Cycler same as other commercial Battery cycler , select cycler mode.
- If your experiment schedule file which you made is potentiostat mode (file extension: cye) and you want to use it's procedure in cycler mode then you just change extension from cye to cyc in file manager etc.

1-4. Virtual control panel

- If you want to stop running the experiment for specified channel(s), Press task button located in each channel row.
- If you want to stop running the experiment for multiple channels simultaneously, then check on channel check box which you want to stop and press Stop task button located in bottom side
- For Resume, Change step function, you must check on the check box and press task button located in button side.

1-5. Calibration

- If you executed Xpciserver.exe or XUSBserver.exe and want to calibrate unused channel, After calibration you MUST press "apply" button and "UPLOAD" button. (If xpciserver or XUSBserver was

not executed, Pressing "UPLOAD" button is no needed.

- On calibration, if you find the abnormal rate value, It means you did mistype the value or hardware has a problem. Normally the rate is between 90-120
- The calibration parameters are updated when you press "apply" button. So you must press "apply" button after you did calibrate by 4th level.
- General procedure: After you press "apply" button, check whether calibration is successful or not by check procedure and then save the calibration file.(Please note that if you did calibrate under xpciserver.exe or XUSBserver.exe executed, you must press "UPLOAD" button)

Chapter2. General Instructions

Please carefully read this operation manual before you start to use WPG.

2-1. Installation

WPG Potentiostat/Galvanostat is only run under WindowsXP or Windows2000 environment. The minimum specification of PC is PentiumⅣ CPU and RAM 256MB and display card supporting 16bit high color and 1024x768 resolution. Interface card need a blank PCI slot inside PC.(If your system is USB version, USB2.0 port is necessary) **WPG use memory address d8000**. So any other peripherals should not use this address. Before you install WPG, please check memory address in control panel – system menu – memory address. If anyone use this address, discard this peripheral from PC and delete information about this unit from system menu.

If you have any queries regarding installation, Contact to WonATech service department.

2-1-1 Hardware Installation.

1) Turn off PC and open the chasis
2) Insert Interface card into blank PCI slot
3) Connect the interface cable between interface card inside PCI and instrument (rear panel).
   * If you system is USB version, ignore above 2) 3) step, and connect USB cable between system and PC
4) Connect cell cables to each channel's cell port
5) Connect AuxV cables(BNC to banana) and thermocouples into Temp module (Option)

2-1-2. Software Installation.

- ➢ To install WPG software, execute setup.exe in setup diskette that was supplied with WPG in WindowsXP/2000 environment. After installation, "WonATech" folder was created in C drive and sub-folders(data, cycle, infor) were also created. (Warning! Don't change folder name. If you change any folder name, WPG may do not work normally)
- ➢ Copy multi.cal file in c:₩wonatech₩infor folder to other safe diskette. This file contains calibration
- ➢ When you finished the software installation, Follow the below procedure.

✓ **Next Steps.**

1) Check Earth ground of power line(Important)
2) Check your Power cord for earth ground
   If you use Multi-tab connector, check it for earth ground
   If any of above one is not for earth ground, prepare them as for earth ground type
3) Turn on the PC

4) Check whether WindowsXP/2000 works normally or not.
5) Turn off PC.
6) Assemble PC case.
7) Turn on PC again
8) Turn on WPG(Check whether Fan is working, Power LED is lighting)
9) If WindowsXP/2000 has no problem without any error message, open wonatech folder in C drive
10) Execute xpciserver.exe or XUSBserver.exe
11) Execute WPGpci_eng.exe ------------------- Ready to run WPG.

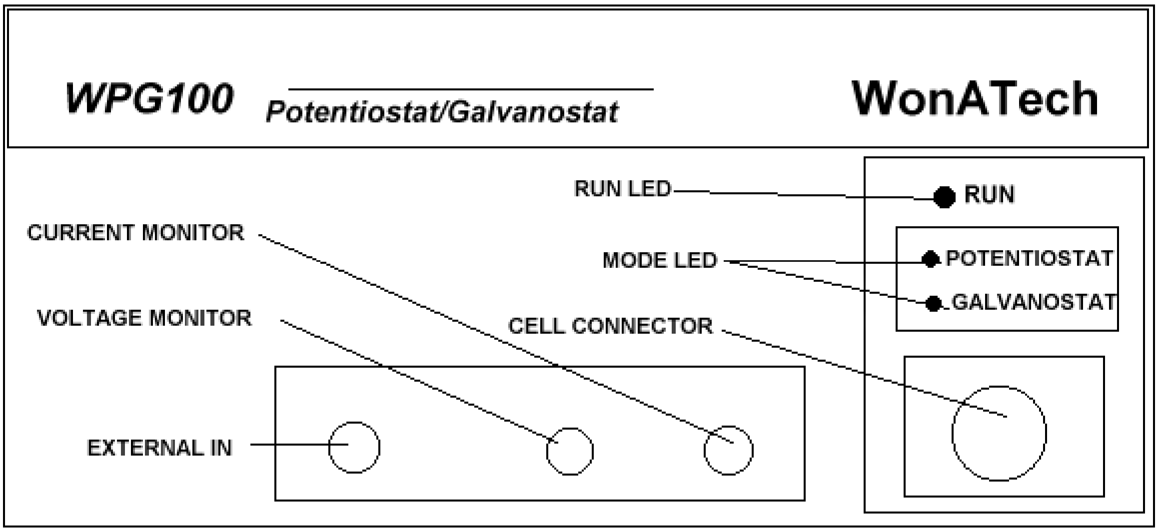
2-2 Checking Point

- Power line cables (PC, Monitor, WPG, Printer etc) should be for earth ground
- Power line for WPG is 220V(**Please check it again**. Some model might be for **110VAC** if you ordered).
- Check the interface card in PC in PCI slot. (If your system is USB version, ignore this step)
- System fault in control panel of WindowsXP/2000
- Virus infection of Software in your PC
- If there is no problem on the above check procedure, Check the WPG following the below procedure using dummy cell (resistor).
- High current range: Connect Positive lead line (Counter + Reference) and Negative lead line (Working+Sense) to 5 Ohm resistor's each terminal.
- Make experiment schedule file as setting current range "High", Control voltage range (+/-5V - +/-50mV), Control current range (<+/-1A, >+/-10mA)
- Medium current range: Connect Positive lead line (Counter + Reference) and Negative lead line (Working+Sense) to 500 Ohm resistor's each terminal.
- Make experiment schedule file as setting current range "High", Control voltage range (+/-5V - +/-50mV), Control current range (<+/-10mA, >+/-100uA)
- Low current range: Connect Positive lead line (Counter + Reference) and Negative lead line (Working+Sense) to 50K Ohm resistor's each terminal.
- Make experiment schedule file as setting current range "High", Control voltage range (+/-5V - +/-50mV), Control current range (<+/-100uA,)

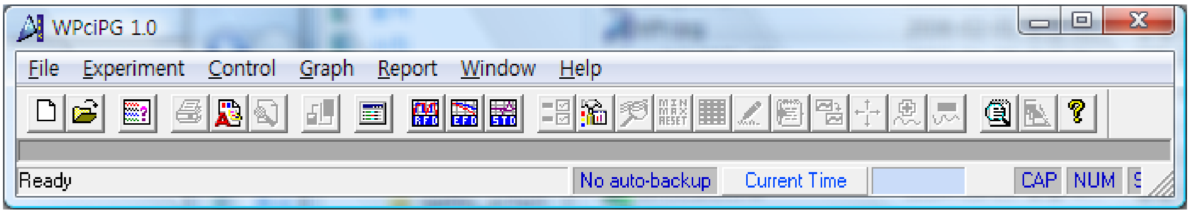
2-3. Caution

- **Please note the cell lead cable connector color as the follows**
  - **Working electrode: Black**
  - **Sense: White**
  - **Reference: Green**
  - **Counter: Red**
- **Don't touch Counter electrode lead during run**
- **Don't remove cell cable lead during run**
- **Don't locate noise source(radio, monitor etc) near by instrument**
- **Don't locate something at botton and rear panel.(There are cooling fans)**
- **Don't power off during run**
- **Don't disassemble the instrument**
- **Place resistor between working+send and counter+reference for unused channel(s).**

2-4 Front panel

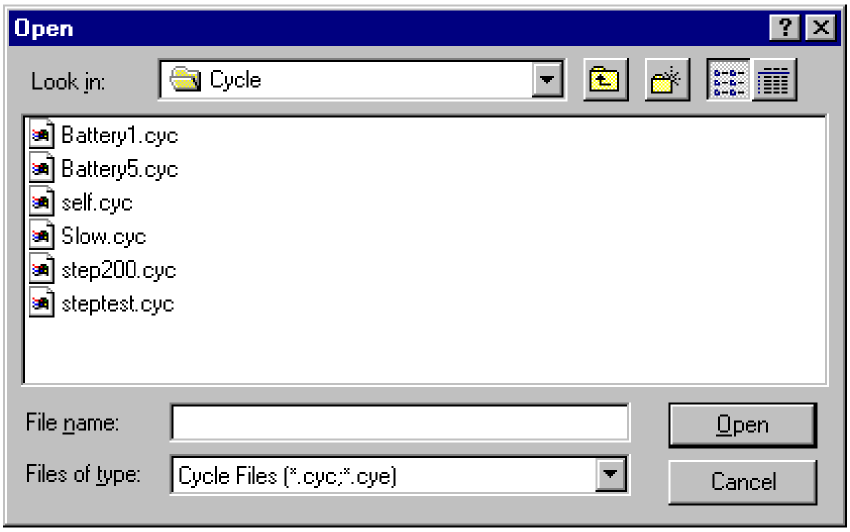


Chapter 3. File Menu



3-1. Open Experiment condition file

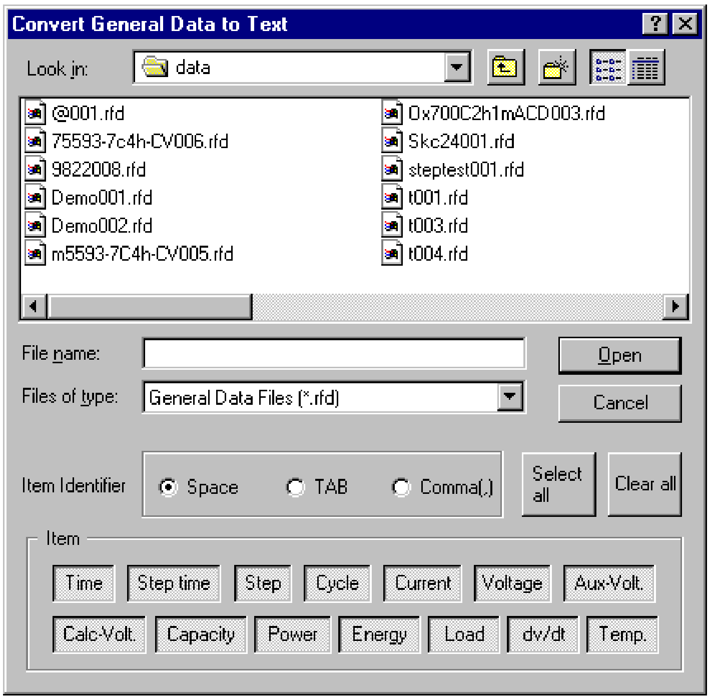
To modify the cycle procedure, open cycle file or press  in tool bar



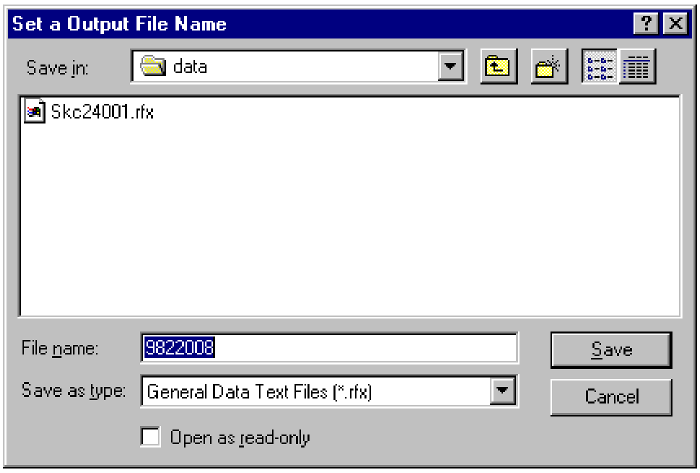
If cycle file type is for potentiostat mode then file extension is cye, for cycler mode then file extension is cyc

3-2. General result file 's ASCII file convert.

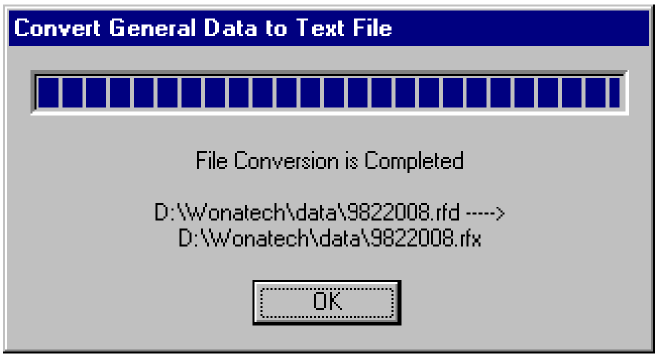
In order to use General data file (binary format file) in other application program, you can convert it to ASCII file. (General data file's extension is rfd; converted ASCII file's extension of general data file is rfx)



- Select general result file that you want to convert.
- Select delimiter
- Select item(s) which you want to convert (default: all items)



- Select target drive and folder and input file name.
- Don't change file extension (rfx)
- Input file name without extension.(file extension will be automatically created)

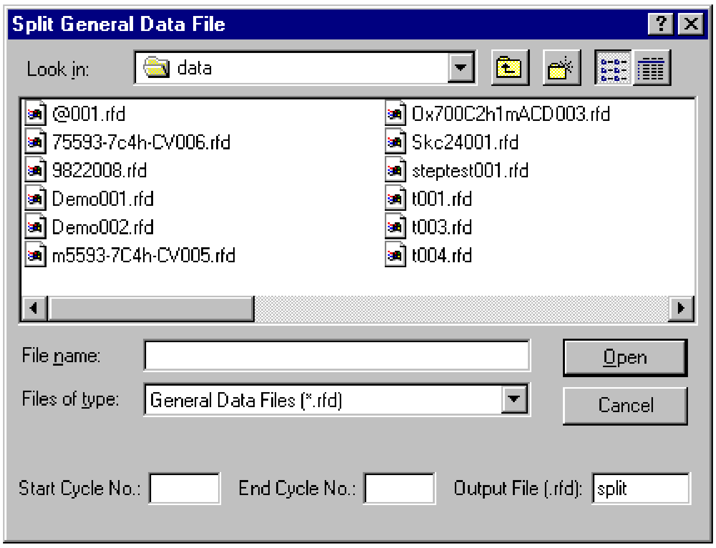


3-3. Cycle result file & capacity result file's ASCII conversion

In order to use cycle result file or capacity result file (binary format file) in other application program, you can convert it to ASCII file. (Cycle result file's extension is efd, converted ASCII file's extension of cycle result file is efx; capacity result file's extension is sfd, converted ASCII file's extension of cycle result file is sfx)

3-4. Split general result file

This split big file to small file by cycle number



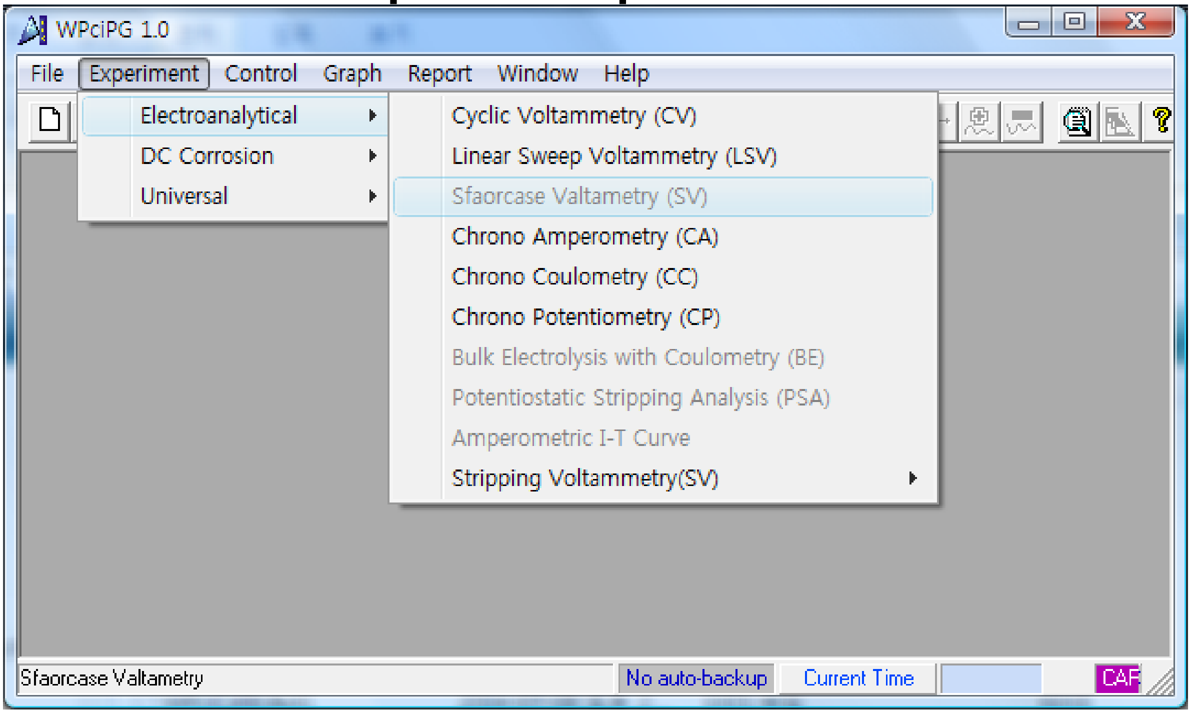
3-5. ASCII file to binary file conversion

Data set from other instruments or modified data set can be converted to binary file in order to use in WPG software.

Note:

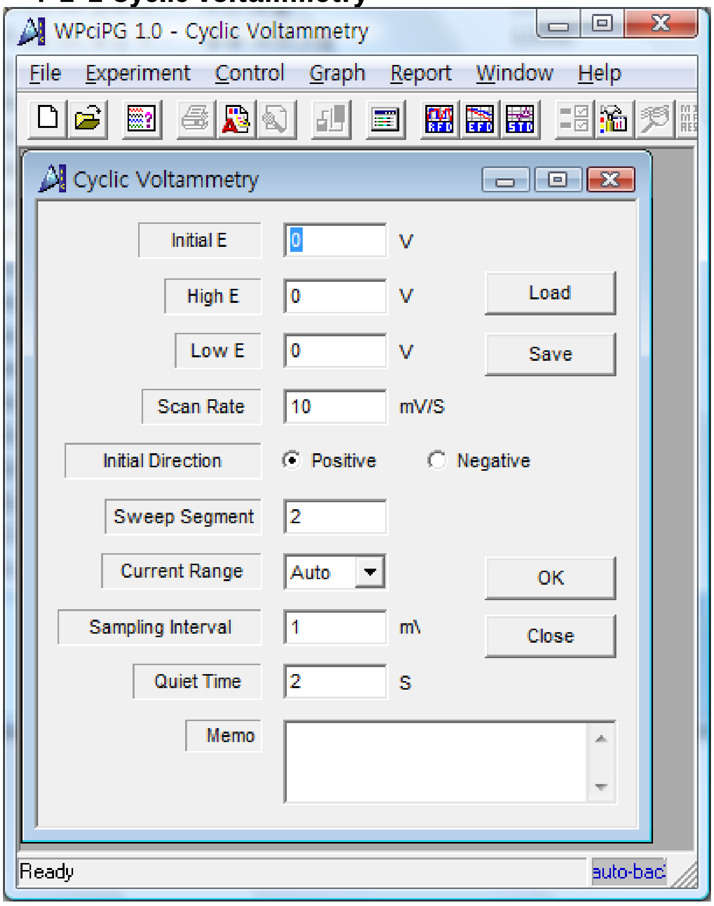
- Each column should be same as format from WPG
- ASCII file extension is same as extension from WPG

Chapter 4. Experiment Menu



4-1. Electroanalytical Techniques

4-1-1 Cyclic voltammetry



Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial potential
High E (V)	-5 - +5	High limit of potential scan
Low E (V)	-5 - +5	Low limit of potential scan
Init P/N	Positive or Negative	Initial scan direction If you select "positive", then the voltage will be scan from Init E to high E and turn back to Low E. If you select "negative", then the voltage will be sweep from Init E to LowE and turn back to High E.
Scan Rate (V/s)	0 - 5V/s	Potential scan rate
Sweep Segments	1 - 9999	Sweep segments, each segments is half cycle
Sample Interval (mV)	1 - 2000	Data sampling interval
Quiet Time (sec)	0 - 9999999	Quiescent time before potential scan
Current range	Auto, manual setting	Sensitivity scale. Default:Auto. If the scan rate is fast, Set the current range as manual.

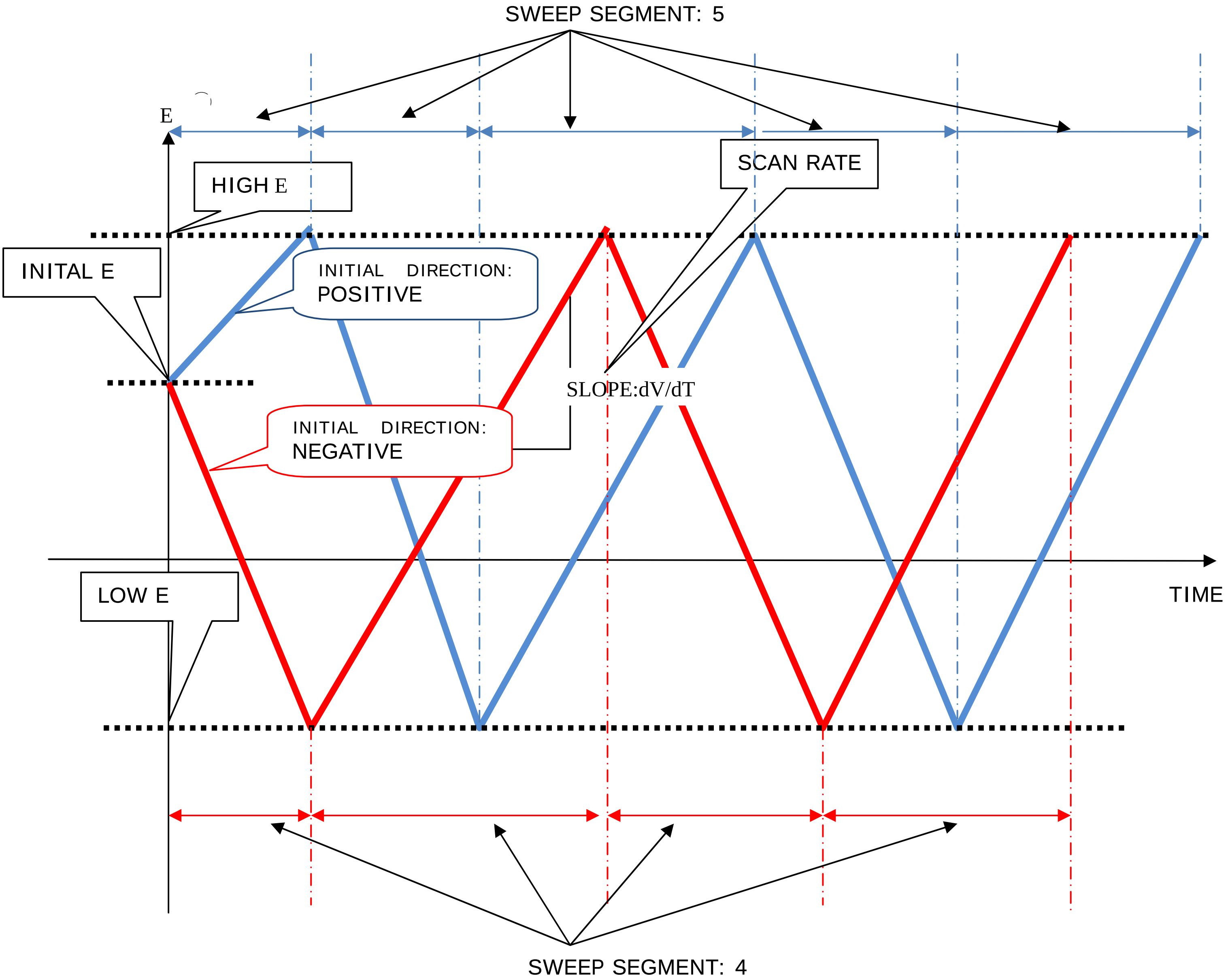
Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)

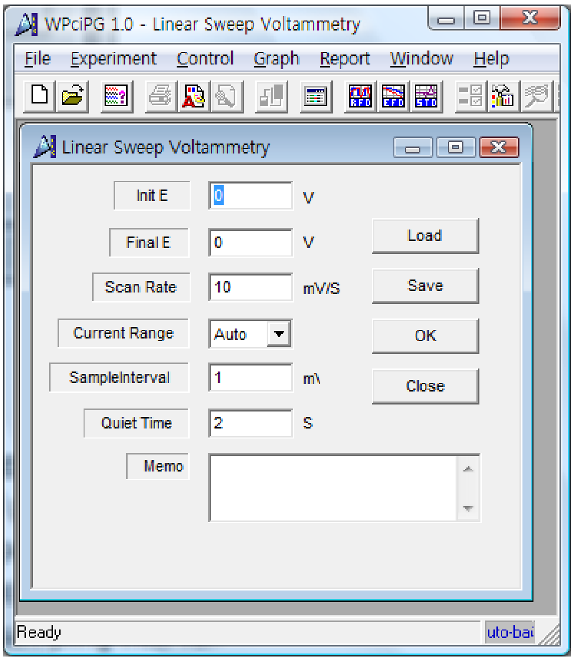
- ID characters should be ECV on file name.

  eg) If you want your file name as ECVtest.cye, then input the name as only "ECVtest"(Do not type file extension) .

2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECV characters.



4-1-2 Linear Sweep Voltammetry

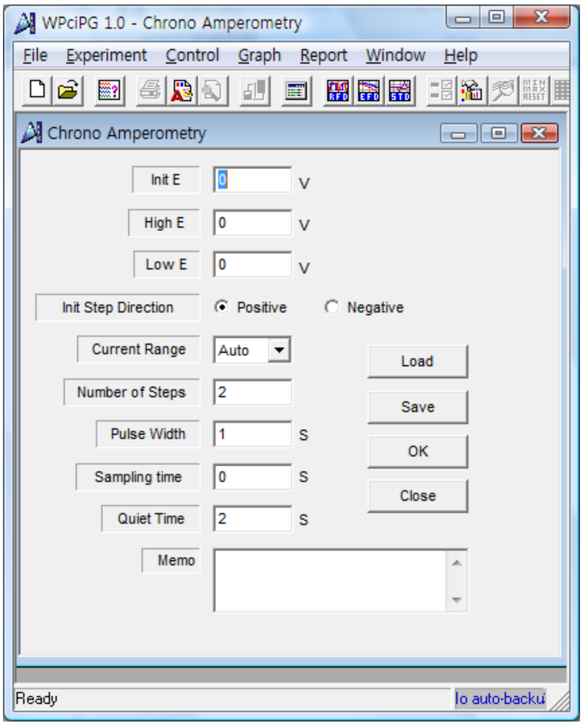


Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial potential
Final E (V)	-5 - +5	Final potential
Scan Rate (V/s)	0 - 5V/s	Potential scan rate
Sample Interval (mV)	1 - 2000	Data sampling interval
Quiet Time (sec)	0 - 9999999	Quiescent time before potential scan
Current range	Auto, manual setting	Sensitivity scale

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be ELSV on file name.
     eg) If you want your file name as ELSVtest.cye, then input the name as only "ELSVtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECV characters.

4-1-3 Chronoamperometry



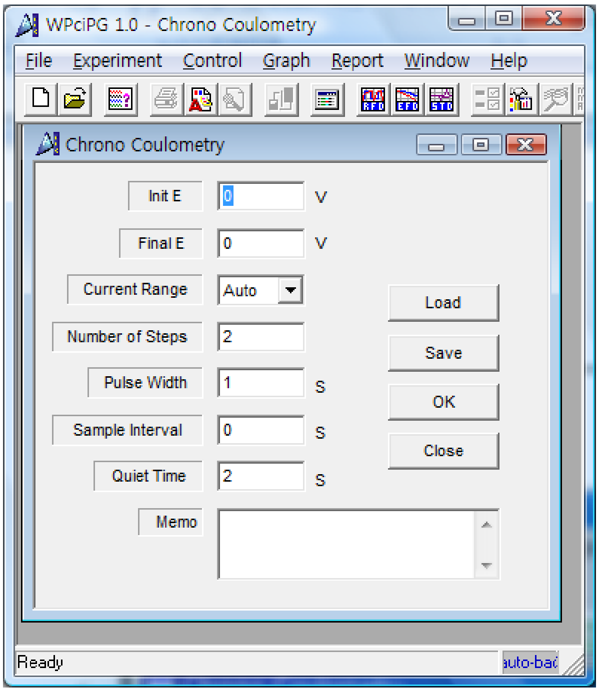
Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial potential
High E (V)	-5 - +5	High limit of potential scan
Low E (V)	-5 - +5	Low limit of potential scan
Init P/N	Positive or Negative	Initial step direction
Number of Steps	1 - 9999	Number of potential steps
Pulse Width (sec)	1 - 999999	Potential pulse width
Sample Interval (s)	0.1 - 999999	Sampling Interval
Quiet Time (sec)	0 - 9999999	Quiescent time before potential step
Current range	Auto, Manual setting	Sensitivity scale

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be ECA on file name.

     eg) If you want your file name as ECAtest.cye, then input the name as only "ECAtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECA characters.

4-1-4 Chronocoulometry



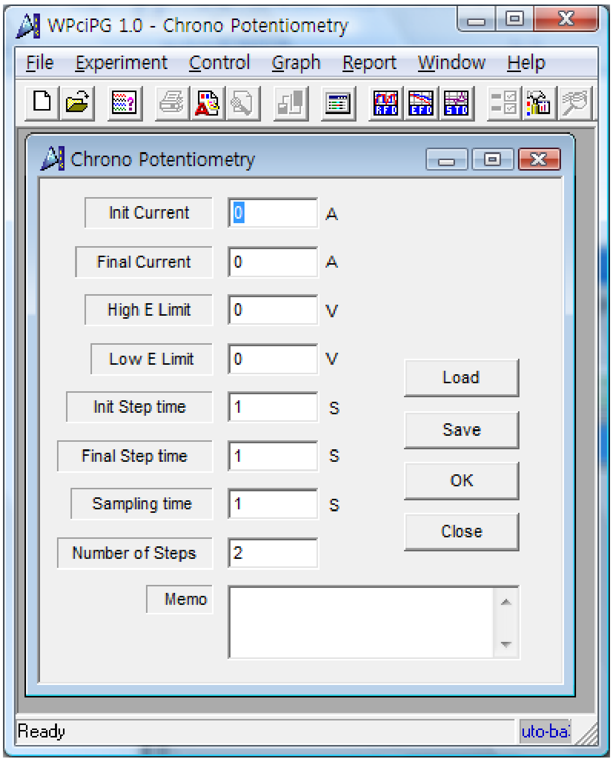
Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial potential
Final E (V)	-5 - +5	Final potential
Number of Steps	1 - 9999	Number of potential steps
Pulse Width (sec)	1-999999	Potential pulse width
Sample Interval (s)	0.1-999999	Sampling Interval
Quiet Time (sec)	0 - 999999	Quiescent time before potential step
Current range	Auto,manual setting	Sensitivity scale

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be ECC on file name.

     eg) If you want your file name as ECCtest.cye, then input the name as only "ECVtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECC characters.

4-1-5 Chronopotentiometry

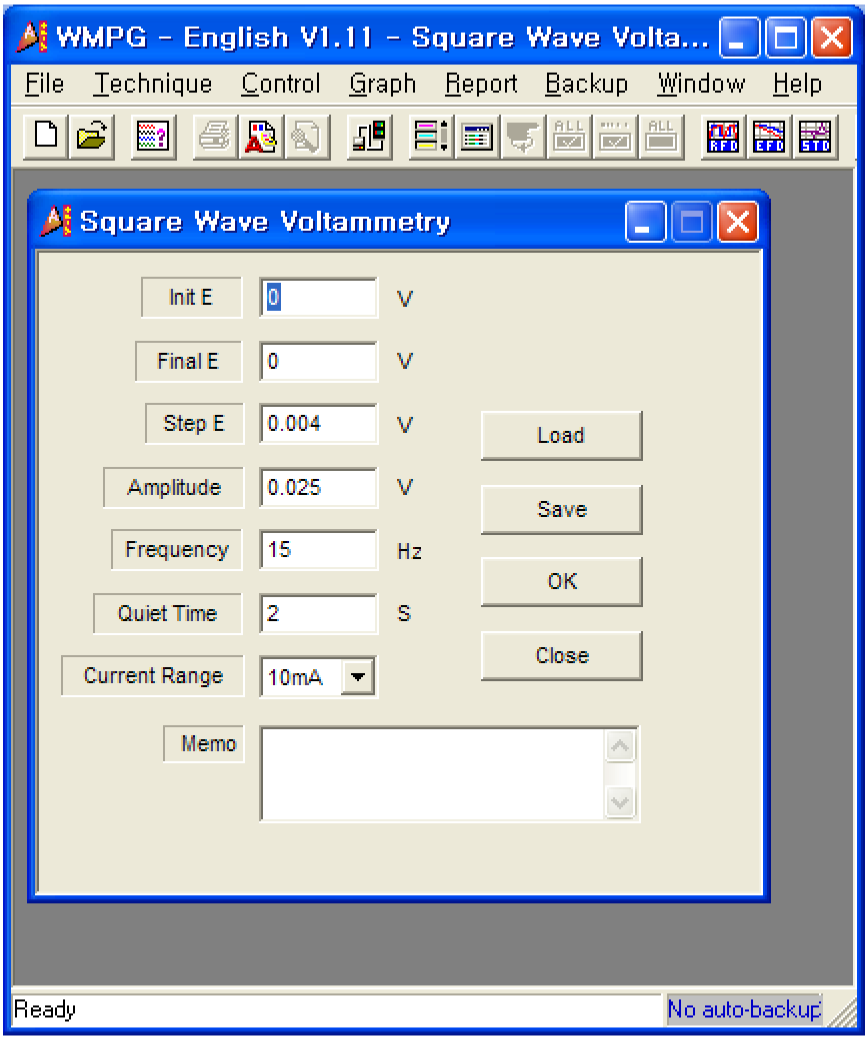


Parameters	***Range***	***Description***
Init Current (A)	-1 – 1	Controlled cathodic current
Final Current (A)	-1 – 1	Controlled anodic current
High E Limit (V)	-5 - +5	High potential limit value
Low E Limit (V)	-5 - +5	Low potential limit value
Init step Time (sec)	1 - 999999	Cathodic run time
Final step Time (sec)	1 - 999999	Anodic run time
Sampling time (sec)	0.1 - 999999	Data storage interval
Number of Steps	1 - 9999	Number of half cycles

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be ECP on file name.
     eg) If you want your file name as ECPtest.cye, then input the name as only "ECPtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECP characters.

4-1-6 Square Wave Voltammetry -Option



Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial potential
Final E (V)	-5 - +5	Final potential
Step E(V)	1 - 9999	Step potential
Amplitude	1-999999	Pulse amplitude
Frequency	0.1-100	Square wave frequency
Quiet Time (sec)	0 - 999999	Quiescent time before potential step
Current range	Auto,manual setting	Sensitivity scale

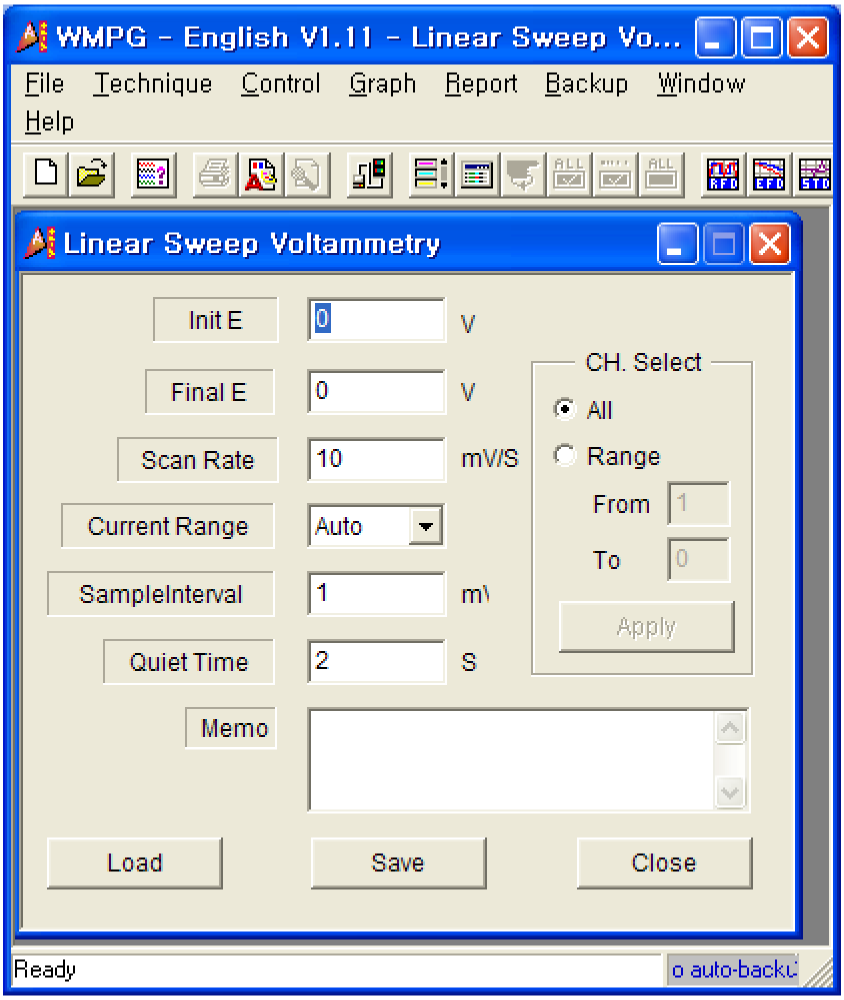
Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be ESWV on file name.
   - eg) If you want your file name as ESWVtest.cye, then input the name as only "ESWVtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECP characters.
3. When you finish the task by pressing "LOAD" or "SAVE", You can see "CH Select" visible. Now you can assign this experiment condition to channel(s) which you want to use.

Please note; If you want to assign the channel(s), Activate control panel by pressing "CTRL" before pressing "APPLY" button.

4-1-7 Stripping Mode – Option

4-1-7-1 Stripping Linear Sweep Voltammetry



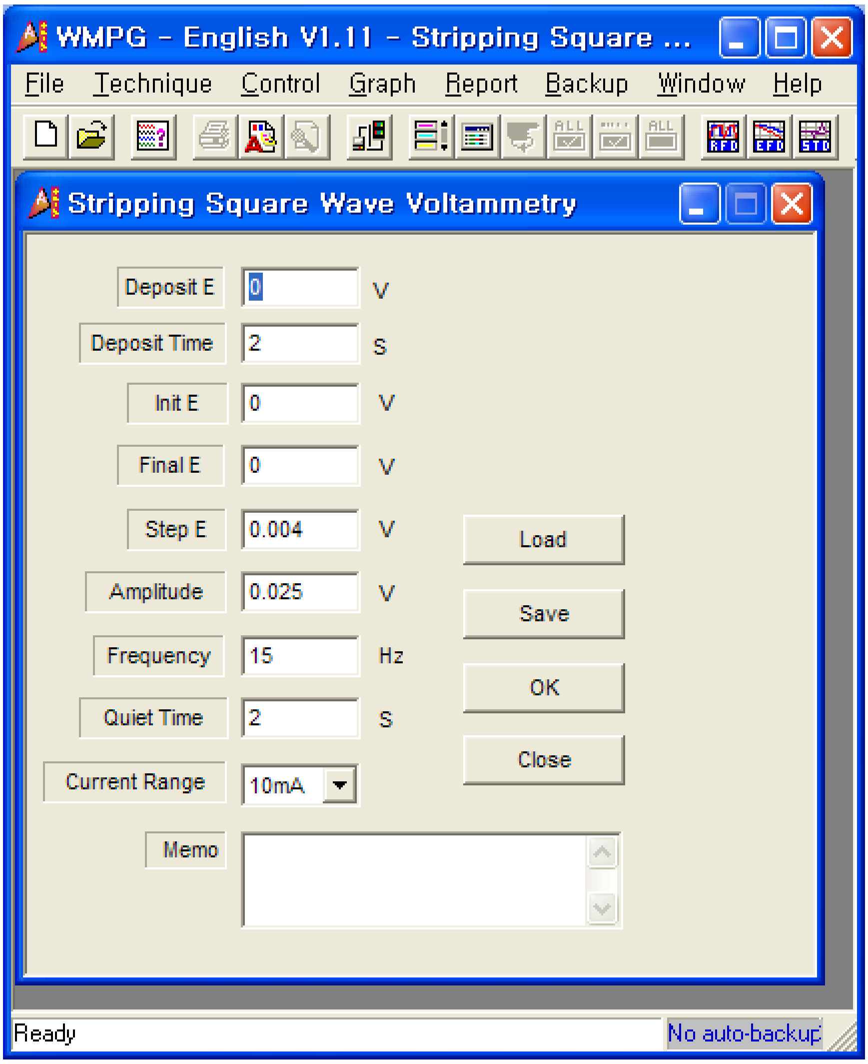
Parameters	*Range*	*Description*
Deposit E (V)	-5 - +5	Deposit potential
Deposit Time (sec)	1-999999	Deposit time
Init E (V)	-5 - +5	Initial potential
Final E (V)	-5 - +5	Final potential
Scan Rate (V/s)	0-5V/s	Potential scan rate
Sample Interval (mV)	1-2000	Data sampling interval
Quiet Time (sec)	0 - 9999999	Quiescent time before potential scan
Current range	Auto,manual setting	Sensitivity scale

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be ELSV on file name.
   - eg) If you want your file name as ELSVtest.cye, then input the name as only "ELSVtest"(Do not type file extension) .

2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECV characters.
3. When you finish the task by pressing "LOAD" or "SAVE", You can see "CH Select" visible. Now you can assign this experiment condition to channel(s) which you want to use.
4. Please note; If you want to assign the channel(s), Activate control panel by pressing "CTRL" before pressing "APPLY" button.

4-1-7-2 Stripping Square Wave Voltammetry -Option



Parameters	***Range***	***Description***
Deposit E (V)	-5 - +5	Deposit potential
Deposit Time (sec)	1-999999	Deposit time
Init E (V)	-5 - +5	Initial potential
Final E (V)	-5 - +5	Final potential
Step E(V)	1 - 9999	Step potential
Amplitude	1-999999	Pulse amplitude
Frequency	0.1-100	Square wave frequency
Quiet Time (sec)	0 - 999999	Quiescent time before potential step
Current range	Auto,manual setting	Sensitivity scale

Notes:

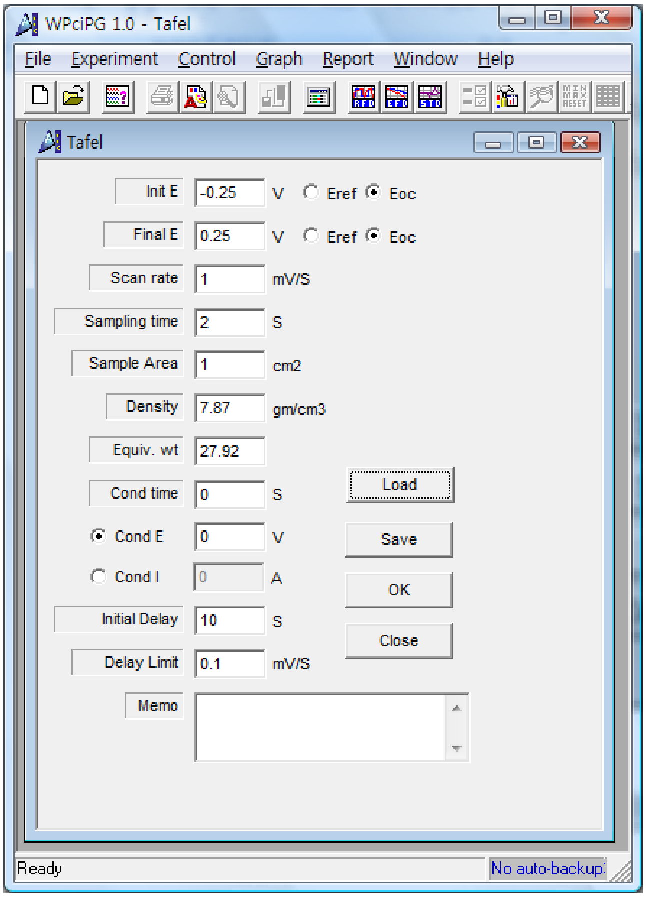
1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be ESWV on file name.
   - eg) If you want your file name as ESWVtest.cye, then input the name as only "ESWVtest"(Do not type file extension) .

2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECP characters.
3. When you finish the task by pressing "LOAD" or "SAVE", You can see "CH Select" visible. Now you can assign this experiment condition to channel(s) which you want to use.

Please note; If you want to assign the channel(s), Activate control panel by pressing "CTRL" before pressing "APPLY" button.

4-2. DC Corrosion Measurement

4-2-1 Tafel Plot



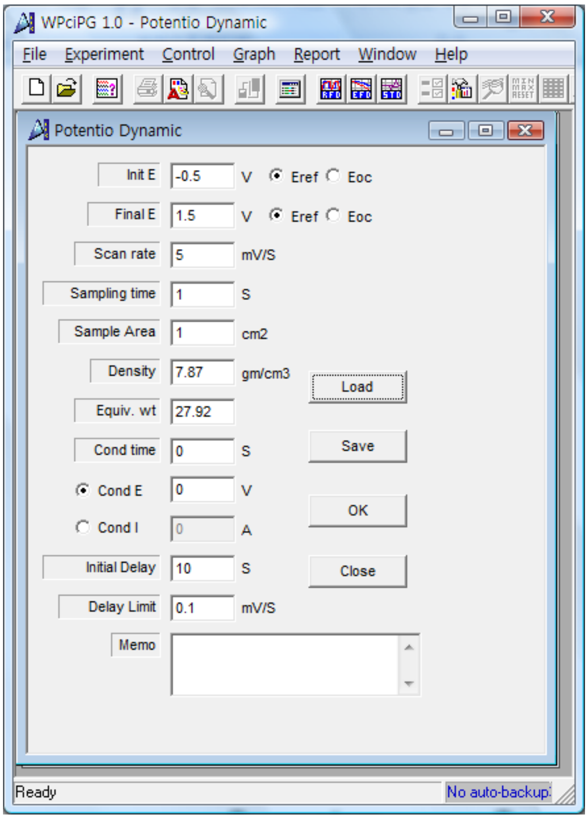
Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial Potential for voltage scanning. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: -250mV/Eoc
Final E (V)	-5 - +5	Scanning End potenial. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: 250mV/Eoc
Sample Area	#######	Electrode Active area
Sampling time (s)	0 - 9,999,999	Data sampling time
Scan Rate (mV/s)	0 - 5000	Potential scanning speed
Condition time(s)	0 - 9,999,999	Pre-treatment time (No data acquisition)
Cond E(V)	-5 - 10	Pre-treatment potential (No data acquisition)
Initial delay (sec)	0 - 9999999	Initial delay time before voltage scanning
Delay limit(mV/s)	0 – 10,000	Waiting condition for stable status. If the voltage fluctuation is less than this specified

value, the experiment goes to next step(experiment starting)

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be TF on file name.
     eg) If you want your file name as TFtest.cye, then input the name as only "TFtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECP characters.

4-2-2 Potentiodynamic

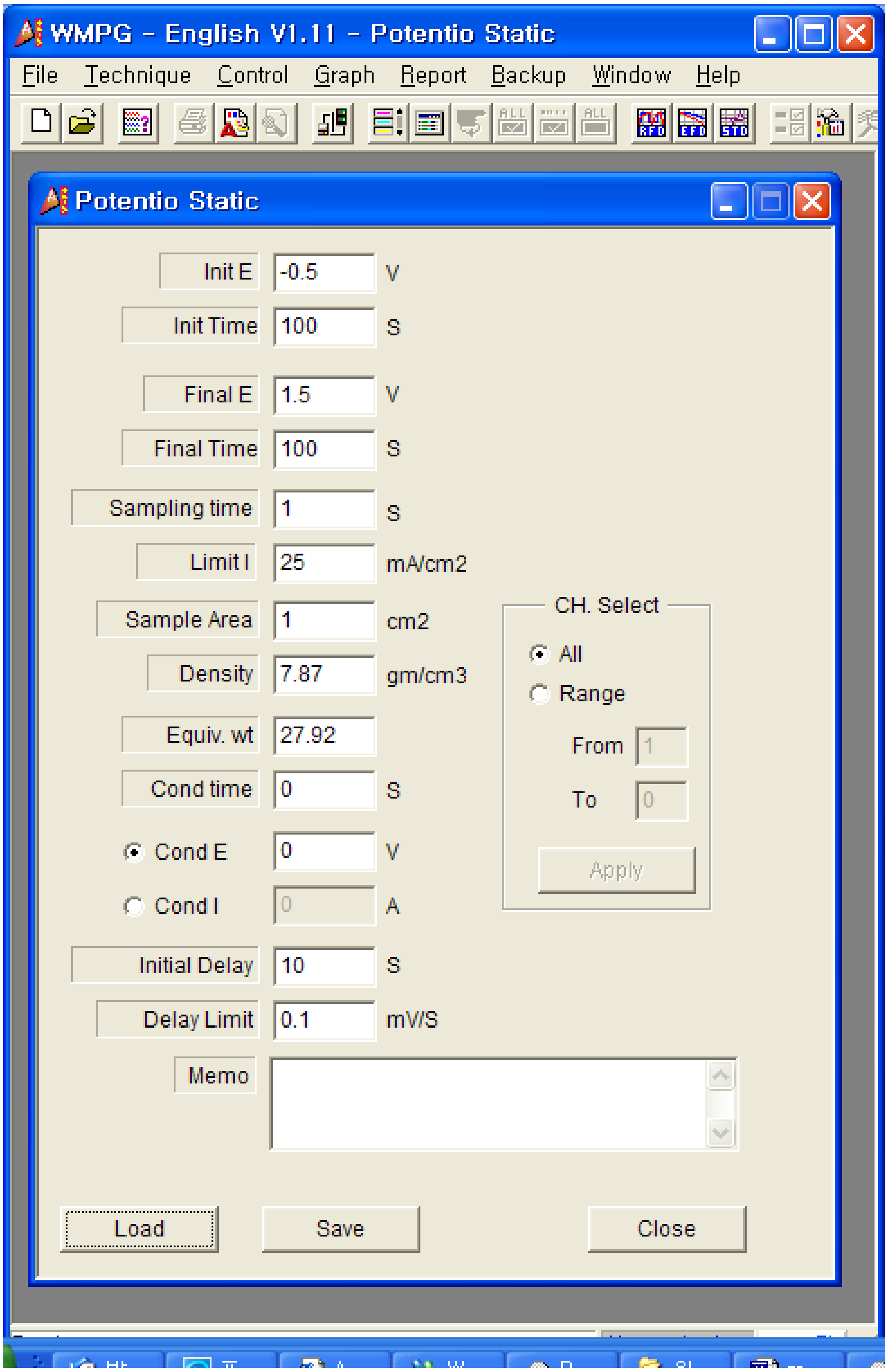


Parameters	*Range*	*Description*
Init E (V)	-5 - +5	Initial Potential for voltage scanning. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: -500mV/Eref
Final E (V)	-5 - +5	Scanning End potenial. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: 1500mV/Eref
Sample Area	#######	Electrode Active area
Sampling time (s)	0 - 9,999,999	Data sampling time
Scan Rate (mV/s)	0 - 5000	Potential scanning speed
Condition time(s)	0 - 9,999,999	Pre-treatment time(No data acquisition)
Cond E(V)	-5 - 10	Pre-treatment potential(No data acquisition)
Initial delay (sec)	0 - 9999999	Initial delay time before voltage scanning
Delay limit(mV/s)	0 - 10,000	Waiting condition for stable status. If the voltage fluctuation is less than this specified value, the experiment goes to next step(experiment starting)

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be PD on file name.
     eg) If you want your file name as PDtest.cye, then input the name as only "PDtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECP characters.

4-2-3 Potentiostatic

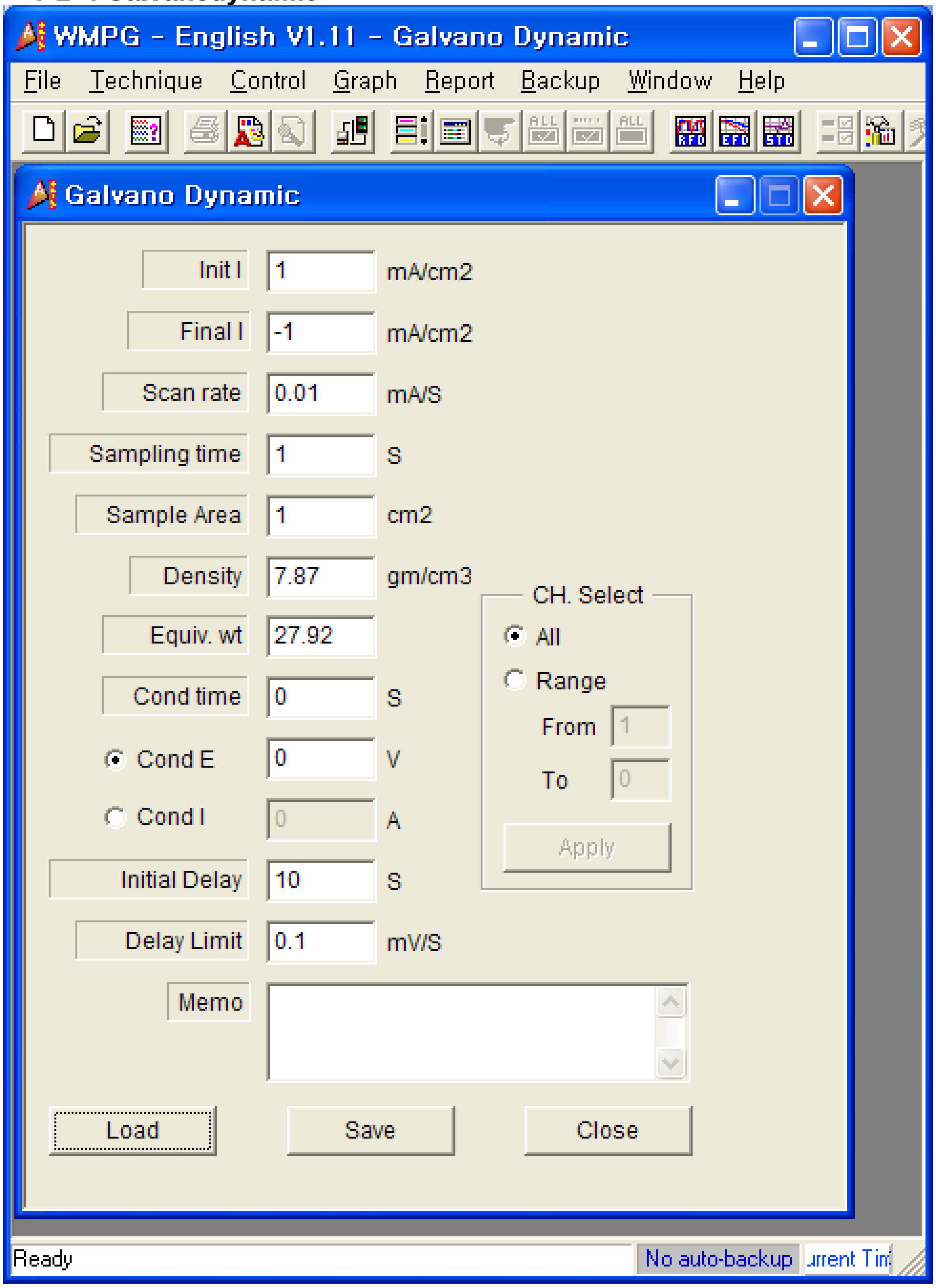


Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial Potential for voltage scanning. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: -500mV/Eref
Init Time(sec)	0- 9,999,999	Initial potential time
Final E (V)	-5 - +5	Scanning End potenial. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: 1500mV/Eref
Final Time(sec)	0- 9,999,999	Final potential time
Sampling time (s)	0- 9,999,999	Data sampling time
Limit I (mA)	0-1000	Limit Current
Sample Area	#######	Electrode Active area
Density(gram/cm^3)	0-9,999,999	Test specimen density
Equiv Wt		Equivalent weight
Condition time(s)	0- 9,999,999	Pre-treatment time(No data acquisition)
Cond E(V)	-5 - 10	Pre-treatment potential(No data acquisition)
Initial delay (sec)	0 - 9999999	Initial delay time before voltage scanning
Delay limit(mV/s)	0 – 10,000	Waiting condition for stable status. If the voltage fluctuation is less than this specified value, the experiment goes to next step(experiment starting)

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be PS on file name.
   - eg) If you want your file name as PStest.cye, then input the name as only "PStest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECP characters.
3. When you finish the task by pressing "LOAD" or "SAVE", You can see "CH Select" visible. Now you can assign this experiment condition to channel(s) which you want to use.
4. Please note; If you want to assign the channel(s), Activate control panel by pressing "CTRL" before pressing "APPLY" button.

4-2-4 Galvanodynamic

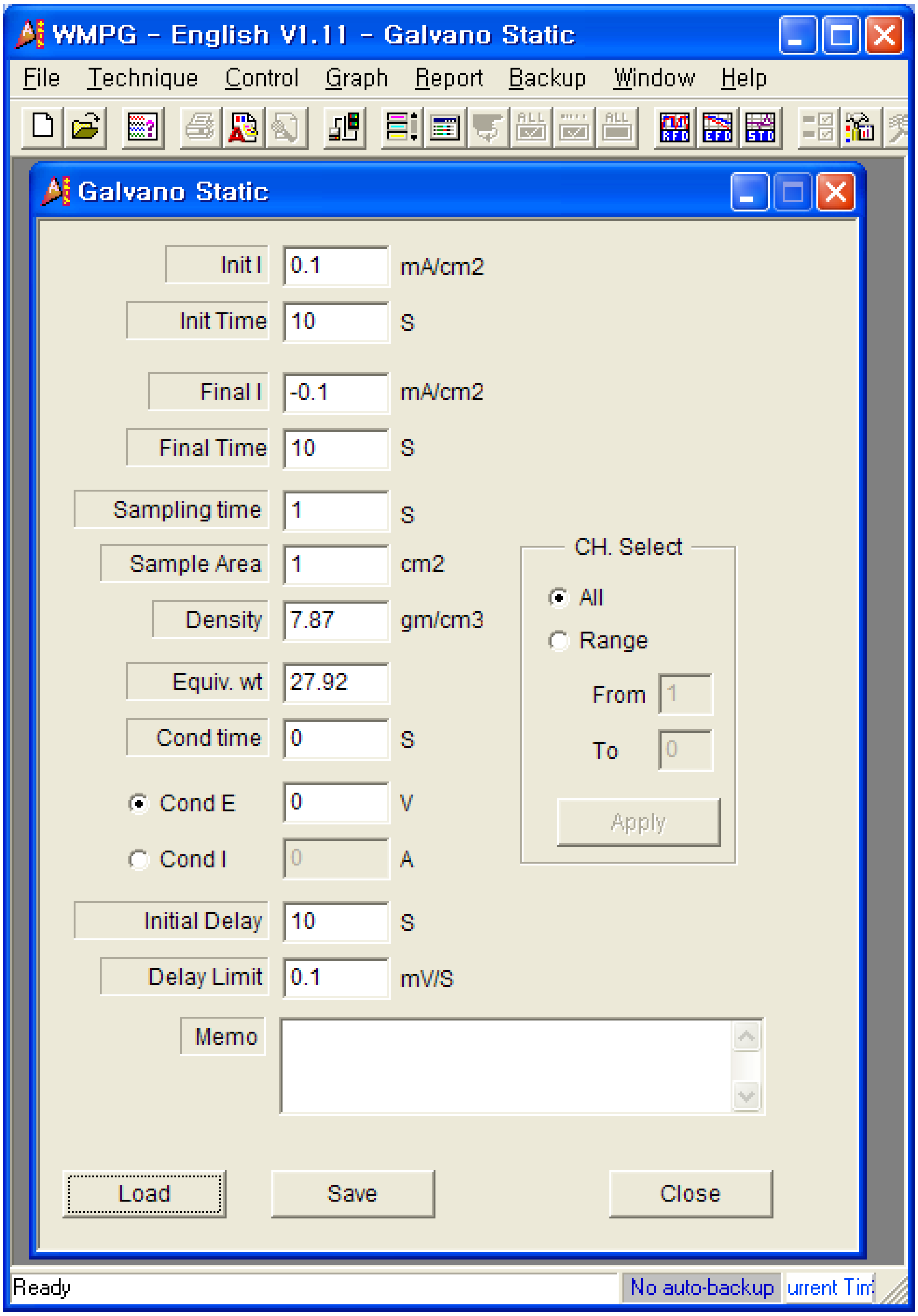


Parameters	***Range***	***Description***
Init I (mA/cm2)		Initial current density for current scanning. default: 1mA/cm2
Final I (mA/cm2)		Scanning End current. default: -1mA/cm2
Sample Area	#######	Electrode Active area
Sampling time (s)	0- 9,999,999	Data sampling time
Scan Rate (mA/s)		Current scanning speed
Condition time(s)	0- 9,999,999	Pre-treatment time(No data acquisition)
Cond E(V)	-5 - 5	Pre-treatment potential(No data acquisition)
Cond I(A)		Pre-treatment current(No data acquisition)
Initial delay (sec)	0 - 9999999	Initial delay time before voltage scanning
Delay limit(mV/s)	0 – 10,000	Waiting condition for stable status. If the voltage fluctuation is less than this specified value, the experiment goes to next step(experiment starting)

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be GD on file name.
   - eg) If you want your file name as GDtest.cye, then input the name as only "GDtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECP characters.
3. When you finish the task by pressing "LOAD" or "SAVE", You can see "CH Select" visible. Now you can assign this experiment condition to channel(s) which you want to use.
4. Please note; If you want to assign the channel(s), Activate control panel by pressing "CTRL" before pressing "APPLY" button.

4-2-5 Galvanostatic

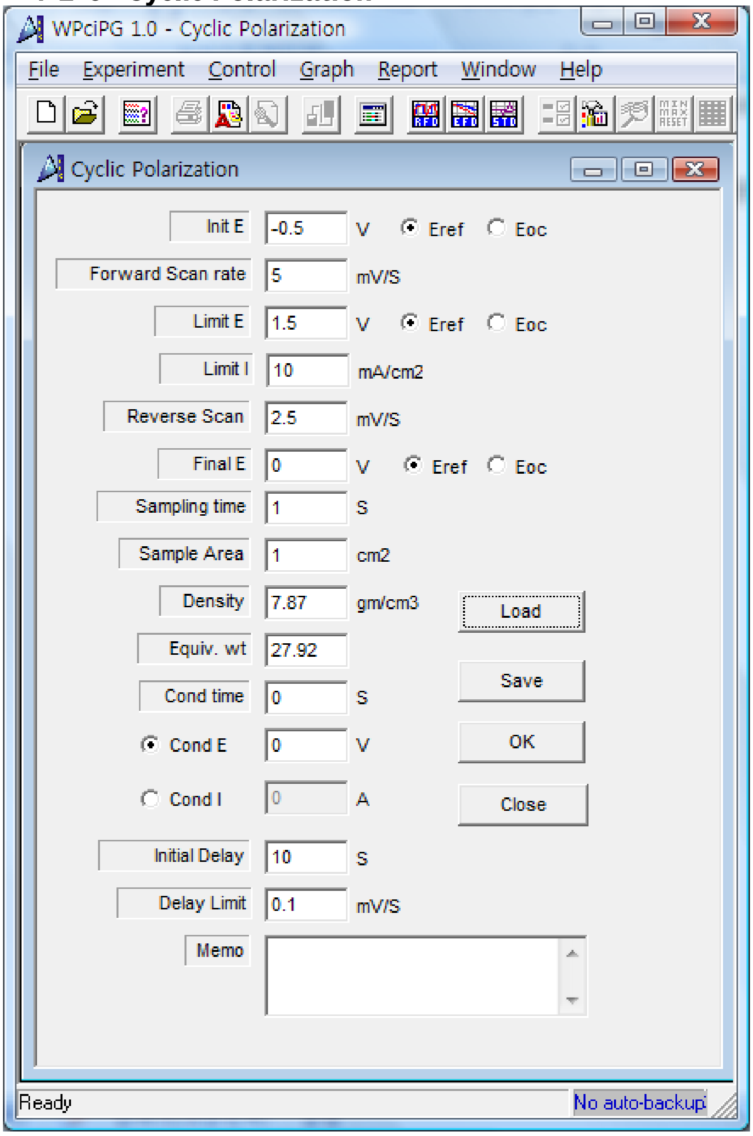


Parameters	***Range***	***Description***
Init I (mA/cm2)	-5 - +5	Initial current density for current scanning. default: 1mA/cm2
Init Time(sec)	0- 9,999,999	Initial current time
Final I (mA/cm2)	-5 - +5	Scanning End current. default: -1mA/cm2
Final Time(sec)	0- 9,999,999	Final current time
Sampling time (s)	0- 9,999,999	Data sampling time
Sample Area	#######	Electrode Active area
Density(gram/cm^3)	0-9,999,999	Test specimen density
Equiv Wt		Equivalent weight
Condition time(s)	0- 9,999,999	Pre-treatment time(No data acquisition)
Cond E(V)	-5 - 10	Pre-treatment potential(No data acquisition)
Cond I(A)		Pre-treatment current(No data acquisition)
Delay limit(mV/s)	0 – 10,000	Waiting condition for stable status. If the voltage fluctuation is less than this specified value, the experiment goes to next step(experiment starting)

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be GS on file name.
   - eg) If you want your file name as GStest.cye, then input the name as only "GStest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECP characters.
3. When you finish the task by pressing "LOAD" or "SAVE", You can see "CH Select" visible. Now you can assign this experiment condition to channel(s) which you want to use.
4. Please note; If you want to assign the channel(s), Activate control panel by pressing "CTRL" before pressing "APPLY" button.

4-2-6 Cyclic Polarization



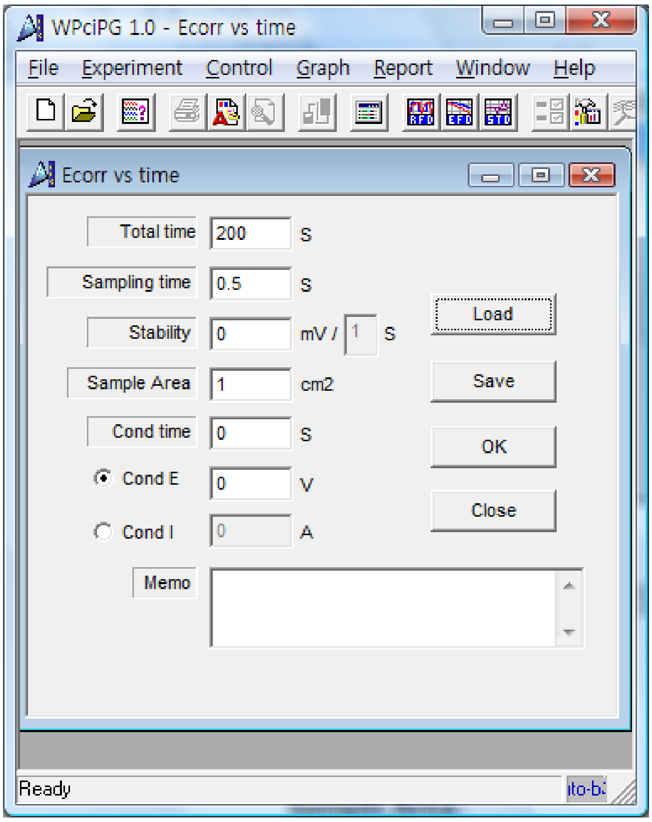
Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial Potential for voltage scanning. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: -500mV/Eref
Forward Scan rate(mV/s)	0 - 5000	Scan rate for forwarding step
Limit E (V)	-5 - +5	Scanning Vertex potenial. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: 1500mV/Eref
Reverse Scan rate(mV/s)	0 - 5000	Scan rate for reversing step
Final E (V)	-5 - +5	Scanning End potenial. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) Default: 0mV/Eref.
Limit I(mA/cm^2)	-1000 - 1000	On scanning, the current value meets this value, the the forwarding step change to reversing step
Sample Area	#######	Electrode Active area

Sampling time (s)	0 - 9,999,999	Data sampling time
Condition time(s)	0 - 9,999,999	Pre-treatment time(No data acquisition)
Cond E(V)	-5 - 10	Pre-treatment potential(No data acquisition)
Initial delay (sec)	0 - 9999999	Initial delay time before voltage scanning
Delay limit(mV/s)	0 - 10,000	When voltage fluctuation will be stabilized under the specified value, the experiment will be started automatically

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be CP on file name.
     eg) If you want your file name as CPtest.cye, then input the name as only "CPtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ECP characters.

4-2-7 Ecorr vs. time

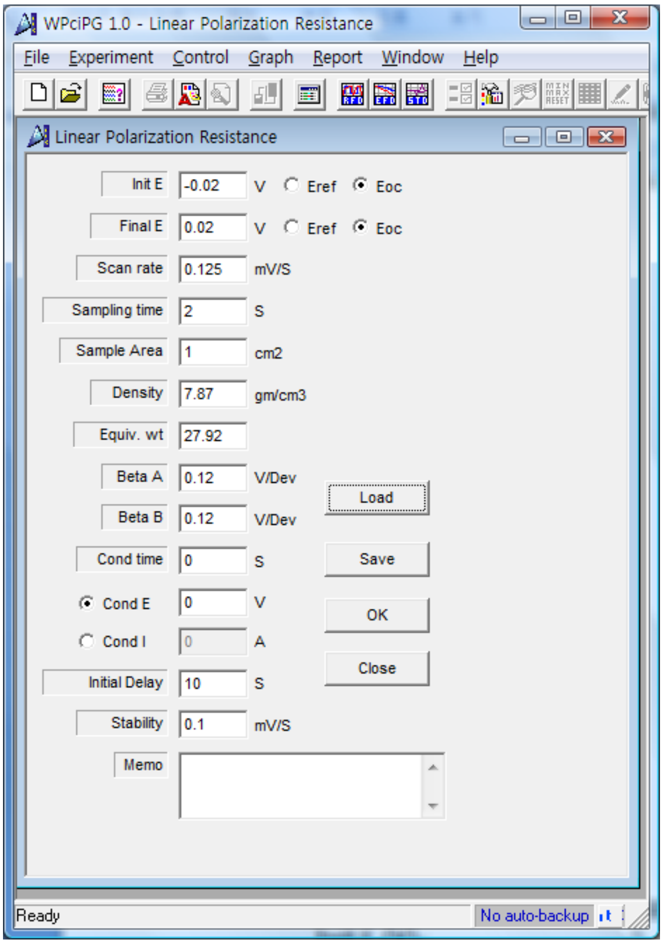


Parameters	***Range***	***Description***
Total time (s)	0 - 9,999,999	Experiment time
Sample Area	#######	Electrode active area
Stability(S/mV)	0 - 10,000	Stabilization condition of voltage fluctuation. If the voltage fluctuation is less than setting value, this experiment procedure will be finished
Condition time(s)	0 - 9,999,999	Pre-treatment time(No data acquisition)
Cond E(V)	-5 - 10	Pre-treatment potential(No data acquisition)

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be ET on file name.
   - eg) If you want your file name as ETtest.cye, then input the name as only "ETtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting ET characters.

4-2-8 Linear Polarization Resistance

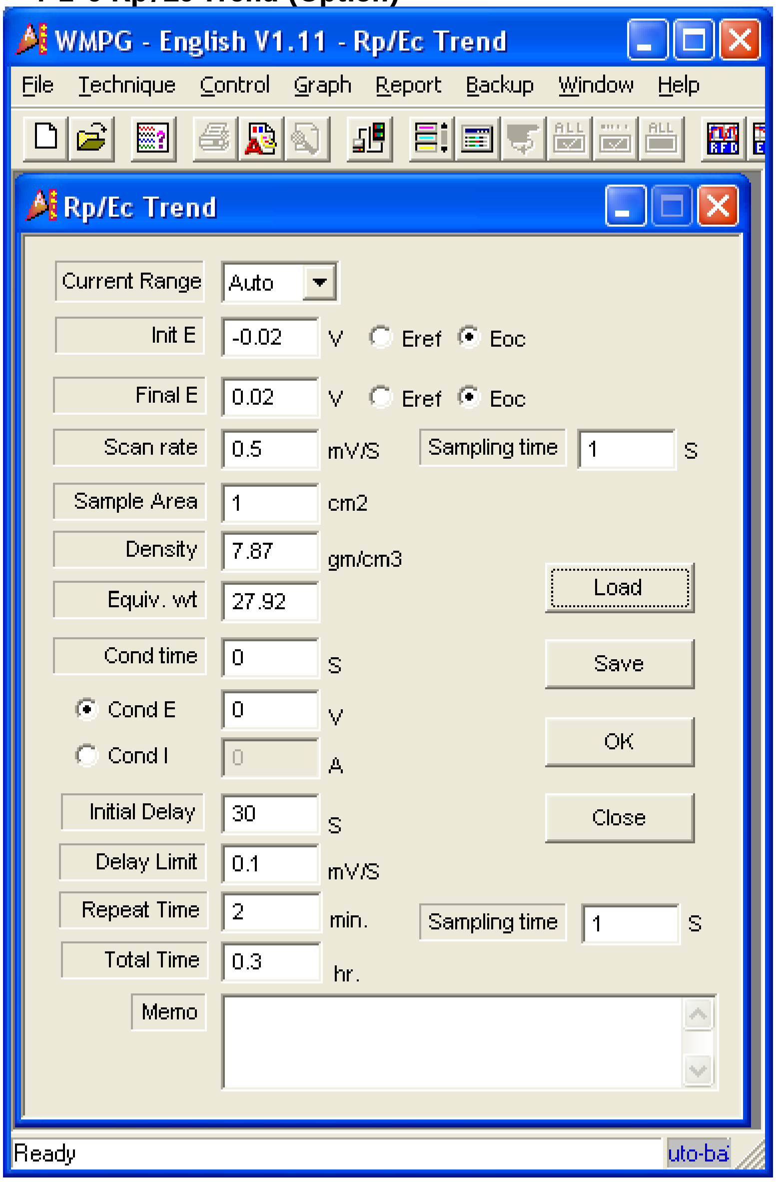


Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial Potential for voltage scanning. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: -20mV/Eoc
Final E (V)	-5 - +5	Scanning End potenial. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: 20mV/Eoc
Sample Area	#######	Electrode Active area
Sampling time (s)	0- 9,999,999	Data sampling time
Scan Rate (mV/s)	0-5000	Potential scanning speed
Condition time(s)	0- 9,999,999	Pre-treatment time(No data acquisition)
Cond E(V)	-5 - 10	Pre-treatment potential(No data acquisition)
Initial delay (sec)	0 - 9999999	Initial delay time before voltage scanning
Delay limit(mV/s)	0 – 10,000	Waiting condition for stable status. If the voltage fluctuation is less than this specified value, the experiment goes to next step(experiment starting)

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be LP on file name.
     eg) If you want your file name as LPtest.cye, then input the name as only "LPtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting LP characters.

4-2-9 Rp/Ec Trend (Option)



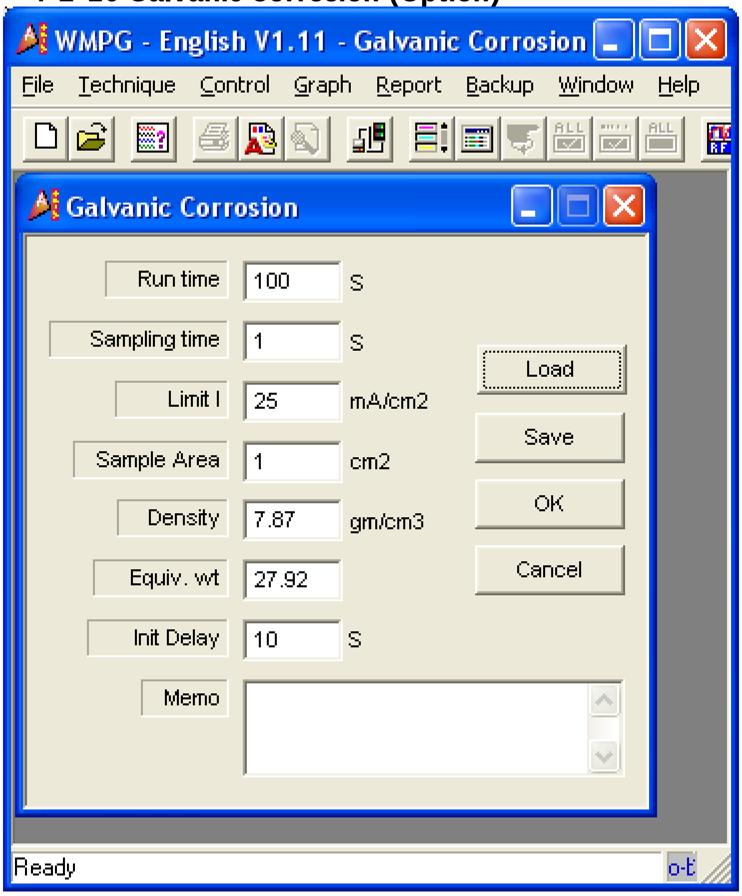
Parameters	***Range***	***Description***
Init E (V)	-5 - +5	Initial Potential for voltage scanning. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: -20mV/Eoc
Final E (V)	-5 - +5	Scanning End potenial. Select the voltage value versus Ecorr(corrosion potential) or Eoc(open circuit potential) default: 20mV/Eoc
Scan Rate (mV/s)	0-5000	Potential scanning speed
Sample Area	#######	Electrode Active area
Density(gram/cm^3)	0-9,999,999	Test specimen density
Equiv Wt		Equivalent weight
Condition time(s)	0- 9,999,999	Pre-treatment time(No data acquisition)
Cond E(V)	-5 - 10	Pre-treatment potential(No data acquisition)
Cond I(A)		Pre-treatment current(No data acquisition)

Condition time(s)	0- 9,999,999	Pre-treatment time(No data acquisition)
Initial delay (sec)	0 - 9999999	Initial delay time before voltage scanning
Delay limit(mV/s)	0 – 10,000	Waiting condition for stable status. If the voltage fluctuation is less than this specified value, the experiment goes to next step(experiment starting)

Notes:

1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be RPEC on file name.
   - eg) If you want your file name as RPECtest.cye, then input the name as only "RPECtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting RPEC characters.
3. When you finish the task by pressing "LOAD" or "SAVE", You can see "CH Select" visible. Now you can assign this experiment condition to channel(s) which you want to use.
4. Please note; If you want to assign the channel(s), Activate control panel by pressing "CTRL" before pressing "APPLY" button.

4-2-10 Galvanic Corrosion (Option)



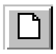
Parameters	***Range***	***Description***
Run time (s)	0- 9,999,999	Experiment time
Sampling time (s)	0- 9,999,999	Data sampling time
Limit I(mA/cm^2)	-1000 - 1000	On scanning, the current value meets this value, the the forwarding step change to reversing step
Sample Area	#######	Electrode active area
Stability(S/mV)	0 – 10,000	Stabilization condition of voltage fluctuation. If the voltage fluctuation is less than setting value, this experiment procedure will be finished
Density(gram/cm^3)	0-9,999,999	Test specimen density
Equiv Wt		Equivalent weight
Init Delay(s)	0- 9,999,999	Pre-treatment time(No data acquisition)

Notes:

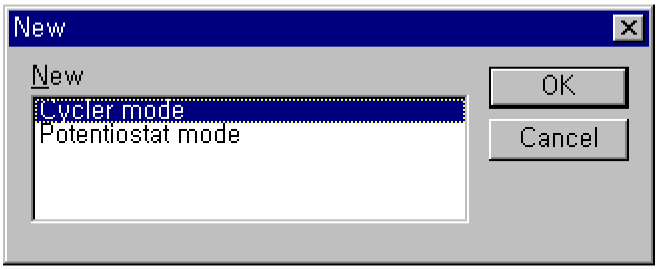
1. When you finish input values on parameters, Save this condition as specified file for use next time. (press "SAVE" button)
   - ID characters should be GC on file name.
   - eg) If you want your file name as GCtest.cye, then input the name as only "GCtest"(Do not type file extension) .
2. If you want to use previously saved file, Press "LOAD" button then you can see the files list starting GC characters.

3. When you finish the task by pressing "LOAD" or "SAVE", You can see "CH Select" visible. Now you can assign this experiment condition to channel(s) which you want to use.
4. Please note; If you want to assign the channel(s), Activate control panel by pressing "CTRL" before pressing "APPLY" button.

4-3. Experiment schedue file creation

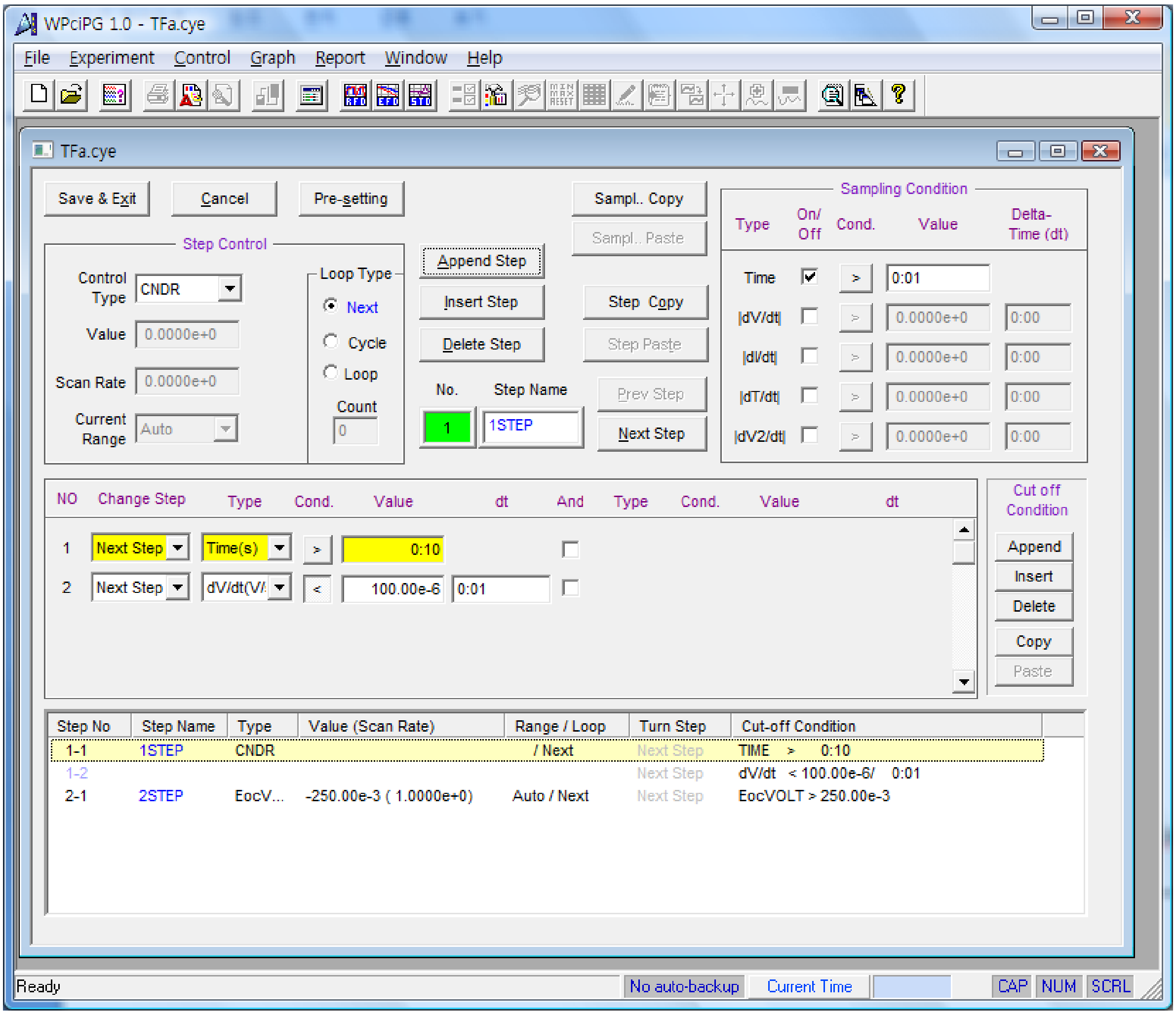
This procedure is how to create charging/discharging step and save it. (Press  in tool bar)

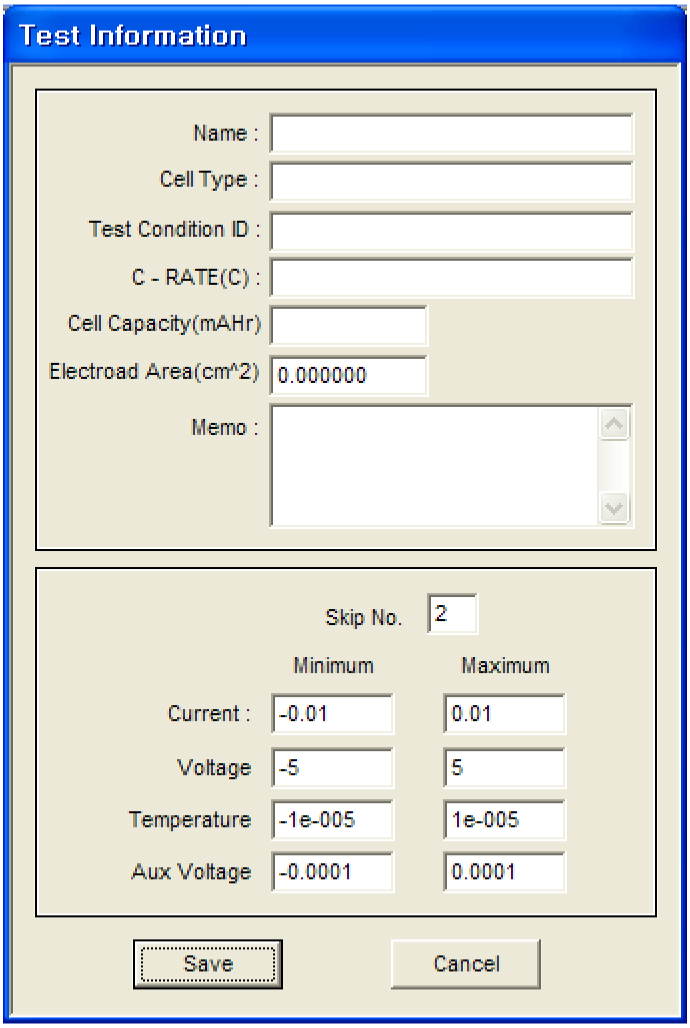
(Option Menu)



You can select "cycler mode" or "potentiostat mode".

- Potentiostat/Galvanostat; Voltage value (for control or measurement) is based on working electrodes voltage vs. Reference electrode voltage.
- Cycler mode: Voltage value (for control or measurement) is based on positive electrode vs. Negative electrode. The connection is Positive electrode (Counter + Reference) and negative electrode (Working+ working sense). So The voltage polarity is opposite in Potentiostat/galvanostat mode and cycler mode.





4-3-1 Test Info.

1) Name: Input name who make experiment schedule file: This name will be automatically described in General result report and Cycle result report. (Max. Character size: 17)
2) Battery chemistry: Input battery type. (E.g., Ni-Cd, Li,SLB etc)(Max. 17characters)
3) Cycle I.D: To distinguish experiment schedule file, Input identification number: This number will be automatically described in cycle result report (Max.17character)
4) C-RATE: Input C-rate number for reference. Max: 17digit
5) Capacity: Input battery capacity (Unit: mAHr): Max.99,999,999,999mAHr
6) Electrode Area: Input electrode area for reference (Unit: cm^2) Max.17digit
7) Memo: Memo field for experiment schedule file (Change line: ctrl+enter)
8) Safety limit Skip number: If any value exceed over limit value on experiment, Skip number without quitting the experiment (Max.999times)
9) Lower, Upper (limit): To protect battery from abnormal voltage or current which can explode the batteries, when Monitored voltage or current value is beyond over setting value, WPG will be automatically stopped.

   ***Tip: This safety limitation setting is for battery itself. For system safety, there is system safety limitation by hardware specification (Max. Current & Max. Voltage). So if any value of current or voltage is over safety limit setting value or system hardware**

specification, WPG will be automatically shut down. In this case, error message of status is "safety"

10) If you finish input on pre-setting, press "save" button then window will be come back to experiment schedule file editor.

4-3-2 Create experiment schedule file

There are 4 sections on this window.

a. Left upper section: Control type & Control value
b. Right upper section: Data acquisition condition
c. Middle section: Cut-Off condition(Vertex condition)
d. Bottom section: Display overall procedure

➢ **Schedule file creation procedure**

1) Press "append step" button by step number. (If you want 5-step procedure, then press "append step" button 5 times; you can make more step later.)
   * Tip: It is more easily when you made steps which you want step numbers.
2) Select control type on combo box (voltage,current,power,load,c-rate,rest,Vscan, Iscan, CondV, CondI, StepV, StepI etc)

Control Parameters

✓ **Voltage**: Constant voltage value (Volt)
The system will apply constant voltage (Potentiostatic control) between working electrode and reference electrode

✓ **Current**: Constant current value (Amp)(+ value: charging, - value: discharge)
The system will apply constant current (Galvanostatic control) between counter electrode and working electrode

✓ **CC/CV**;(option) Apply constant current till setting voltage value and apply constant voltage as setting value till cut-off condition satisfied

✓ **Power**: Constant power value (watt): WPG reads voltage value and apply calculated current value from formula (P=V*I). (+ value: charging, - value: discharging)

✓ **Load**: Constant load value (Ohm): WPG reads voltage value and apply calculated current value from formula (E=I*R) (+ value: charging, - value: discharging)

✓ **C-rate**: Read capacity value on "pre-setting" capacity information and apply current based on capacity following C-rate value.

A. Tip: C-rate? => If capacity is 1500mAHr and C-rate is 0.5, then 750mA current will be applied

✓ **Vscan**: Voltage scanning: The voltage will be start scanning from the setting value (volt) with

setting scanning speed (mV/sec) until the cut-off condition is satisfied.
The voltage is working electrode voltage vs. reference electrode for potentiostat mode (cye) or reference electrode(counter electrode) voltage vs. working electrode for cycler mode(cyc)

A. Scanning speed value's polarity

B. Positive value: Positive direction

C. Negative value: Negative direction

- ✓ **IScan**: Current scanning: The current will be start scanning from the setting value (Ampere) at specified scanning speed (mA/sec) until the cut-off condition is satisfied.

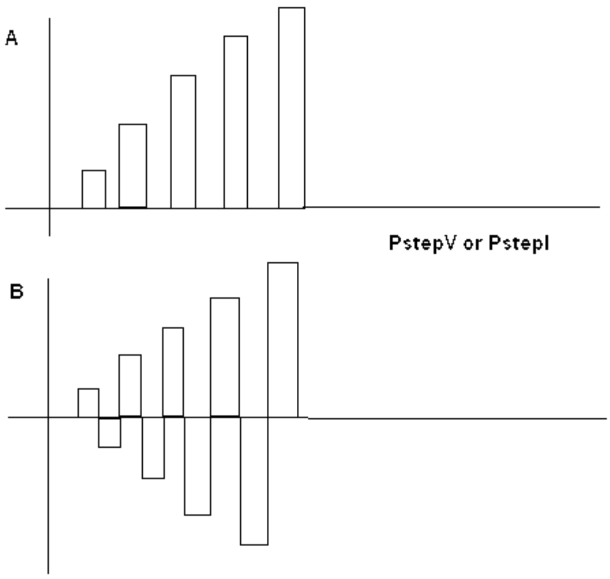
  A. Scanning speed value's polarity

  i. Positive value: Positive direction

  ii. Negative value: Negative direction

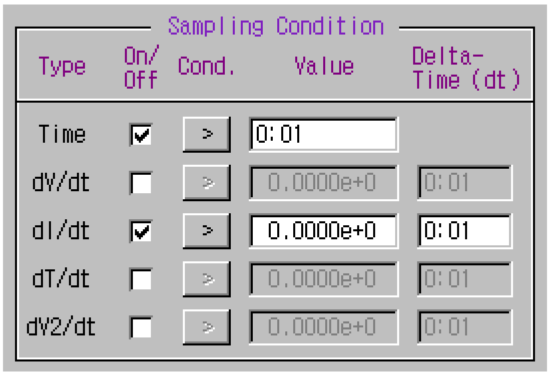
- ✓ **CondV**: constant voltage value(volt);Same as voltage control but the timer is stop within this step (This control mode is for conditioning or pretreatment of the electrode; for cleaning etc.)
- ✓ **CondI:** constant current value(Amp);Same as current control but the timer is stop within this step (This control mode is for conditioning or pretreatment of the electrode; for cleaning etc.)
- ✓ **StepV**: Add setting voltage value (Volt) to previous step's voltage value.
  For staircase voltammetry or Electrochemical voltage spectroscopy(EVS) etc
  The voltage is working electrode voltage vs. reference electrode for potentiostat mode (cye) or reference electrode(counter electrode) voltage vs. working electrode for cycler mode(cyc)
- ✓ **StepI**: Add setting current value(Amp) to previous step's current value
  For IV curve etc.
- ✓ **Rest**: Open circuit condition. The instrument does not apply power to the cell and measure the voltage value only. (Timer is working)
  To measure or determine open circuit potential or wait for stable electrode surface interaction.
- ✓ **CondR**: Same as Rest but the timer is stop within this step
  To measure or determine open circuit potential or wait for stable electrode surface interaction.
  (This control mode is for conditioning or pretreatment of the electrode; for cleaning etc.)
- ✓ **LastV**: Apply previous step's last reading voltage (Constant voltage)
- ✓ **LastI**: Apply previous step's last reading current (Constant current)
- ✓ **OCV**: Read open circuit voltage and apply it's value (Constant voltage)
- ✓ **ZRA(option)**: Zero resistance ammeter for Galvanic corrosion measurement etc.Needs Aux. Voltage input option (Refer to the ZRA connection)
- ✓ **EocVscan**: Need previous step as REST or CondR. Voltage scanning based on open circuit potential.

- **LastVscan**: Voltage scanning based on previous step's reading last voltage value
- **PstepV**: Adding the specified voltage value on the step value before previous step's voltage value
- **PstepI**: Adding the specified current value on the step value before previous step's voltage value
- PstepV, PstepI example

1. 

- **PulseV(option)**: voltage or current pulse profiling
    i. current pulse profiling for GSM or CDMA test or pulse plating etc
- **SWV(option):** Square Wave Generation

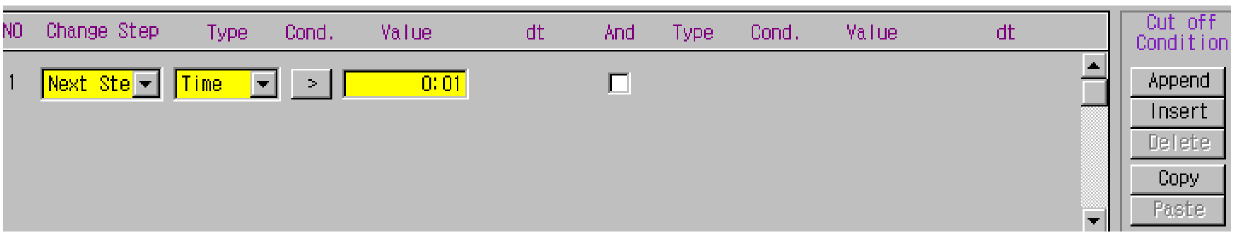
3) Input value (e.g., 100mA=0.1 or 1e-1)
4) Select current range(H(High):over 10mA , M(Medium): over 100uA, L(low): below 100uA or Auto: Default: Auto) ; The current value is example for 1A, 10mA, 100uA system.
    - Tip1: If scanning speed is fast, then set current range as manual
    - **Tip2: If the system configuration has different current ranges per channels, 1st channel's current specification will be display. But if this experiment schedule file is used for other channel, it will meet other channels specification**.
5) Cycle/Loop: Repeat time
    - If you want unlimited repeat, then you can select "NEXT".
6) Step Name: WPG make step name automatically but if you want specified name, you can input your step name to identify specified step.
7) Data Acquisition



- If you click on "check-on" box, data is recorded when this condition is satisfied. (Each row condition is or logic)
- : If any of condition is satisfied, data is recorded.
- Time duration(sec): data is recorded following input time(default: 1sec)
- Time input method: Second unit input (9999sec) or 1 10 10(1hr10min10sec)
- dV/dt: voltage change during dt
- dI/dt: current change during dt
- dT/dt: temperature change during dt
- dV2/dt: auxiliary voltage change during dt

8) You can move each step by pressing "next step" "Prev step' or clicking step on "overall procedure display" window.

9) Setting cutoff condition



Cut-Off (Vertex) condition

- You can find right side buttons (append, insert, delete, copy & paste button)
- If you think several cut-off condition, press append button several times. Each condition is OR logic. (If any of conditions is satisfied, then step moves to specified step).
- Cut-off condition's priority: cut off condition number 1 is highest.
- Cut-off type
  - ✓ time, voltage, current, capacity,-dV, dV/dt, dI/dt, FCC, FCD, LCC, LCD, V2, V3, Temp, dT/dt, C-time, L-time, EocVolt

- ✓ Input value
  - ➢ e.g.) 0.0035 or 3.5e-3
  - ➢ time input: #####;##;## or #########(sec).

    (Maximum 99999hr59min59sec or 99,999,999,999sec)

    e.g.): input:9999 = 9,999sec

    i. Input:12:65 = 13min5sec

    ii. input: 1:0:0= 1hr

    iii. input: 256h26m30s = 256hr 26min 30sec

    iv. input: 50 0 30 = 50hr 30sec

    v. input: 1-26-80 = 1hr 27min 20sec
- ✓ If you select dV/dt, dI/dt, dT/dt etc(dt based condition), dt value is activated
- ✓ Cut off parameters

1) Time: Step time
2) Voltage: Unit (Volt)
3) Current; Unit(Ampere)
4) Capacity: Unit(Ahr)
5) -dV: Minus deltaV for NiCd battery or NiMH battery
6) dV/dt: voltage slope
7) dI/dt: Current slope
8) FCC((Percent Capacity of First Cycle Charge): Percentage based on the first cycle's charging capacity value
9) FCD(Percent Capacity of First Cycle Discharge): Percentage based on the first cycle's discharging capacity value
10) LCC(Percent Capacity of Last Cycle Charge): Percentage based on previous cycle's charging capacity value
11) LCD:(Percent Capacity of Last Cycle Discharge): Percentage based on previous cycle's discharging capacity value
12) V2: Auxiliary voltage
13) V3: Calculated voltage (V+V2 or V-V2 or V2-V)
14) Temp: Unit C
15) dT/dt: Temperature slope

16) C-time(Cycle working time): time from cycle start.

17) L-time(Loop time) time from Loop start

18) EocVolt: voltage based on Open ciruit potential

19) |dV/dt|: Absolute value of dV/dt

20) |dI/dt|: Absolute value of dI/dt

21) |dT/dt| Absolute value of dT/dt

- Select < or >
- dt(dV/dt, dI/dt,dT/dt etc) condition: dt means value change dt time duration. Eg) dt=10 then value change between 10seconds previous data and current data.
- Input value: unit(sec,V, A,% etc)
- If you check on "And" box then two condition is "and" logic. (Only if current data is satisfied left condition and right condition together then step moves to specified step)
- Step Name: Select Target step name when cut-off condition is satisfied
- If you press right side "Append" button, new cut-off condition is created. Each cut off condition is or logic. You can set target step as different step for each condition.
- If cut-off condition is same as the others step's, then you can use "copy" and "paste".

10) When you finish to create cycle procedure, Press "save & exit" button then you can save this file with your file name.

✓ Note: Input file name without extension. Extension distinguishes cycler mode and potentiostat mode. If you typed "test.cyc" in cycler mode file creation, then file name will be test.cyc.cyc

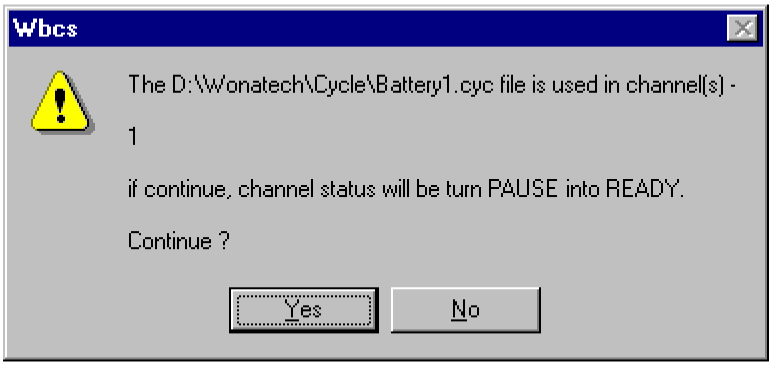
✓ If you tried to save the experiment schedule file as same file name, the following message might be displayed. This message means that another channel(s) is(are) running with same file name.

✓ You can save this file with different file name.

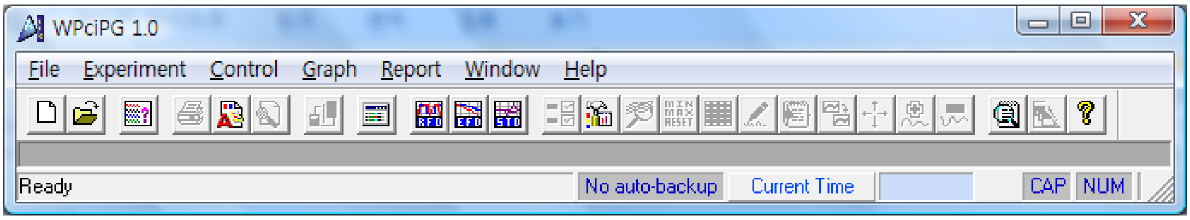


✓ If you see the following warning message when you tried to save experiment schedule file as same file name, It means that there is (are) channel(s) which is (are) stopped (not finished). Stopped channels can be resume with same experiment schedule file. You can

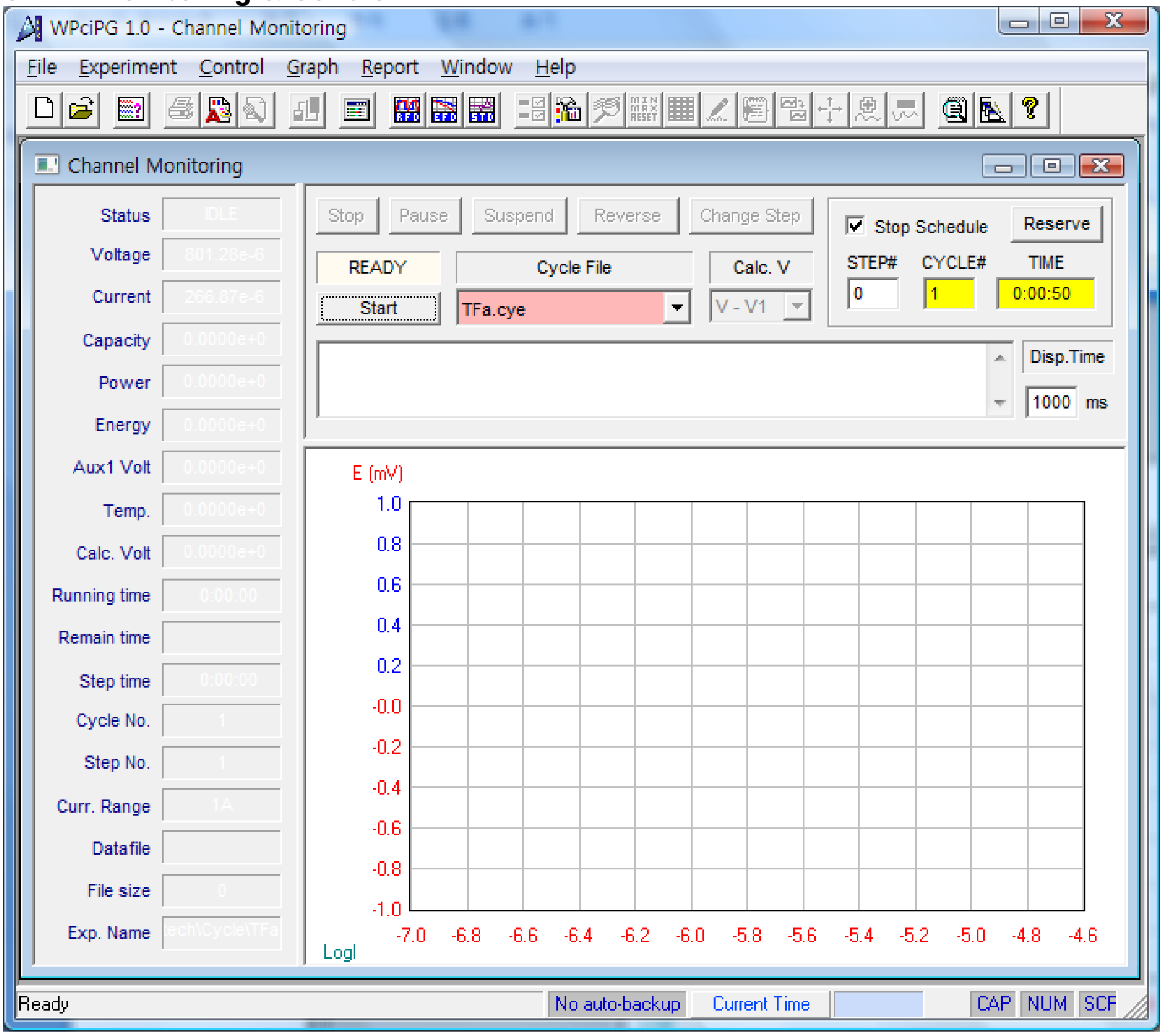
save same file name but the stopped channel status will be change from stop to ready. (They will not be able to resume) Or you can save the file as different name.



Chapter 5. Control Menu

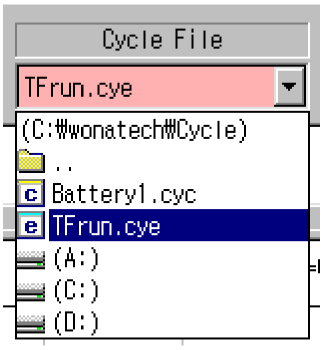


5-1. Monitoring & Control



Virtual control panel appears like above screen shot when you press "CTRL" on tool bar. In this panel, You can select cycle condition file and you can start, stop, suspend etc.

Whenever you can press "CTRL" to activate virtual control panel. But if it does not activate, it means that xserver.exe was not loaded.



You can see buttons located in upper side. They are for monitoring data set.

Experiment Procedure

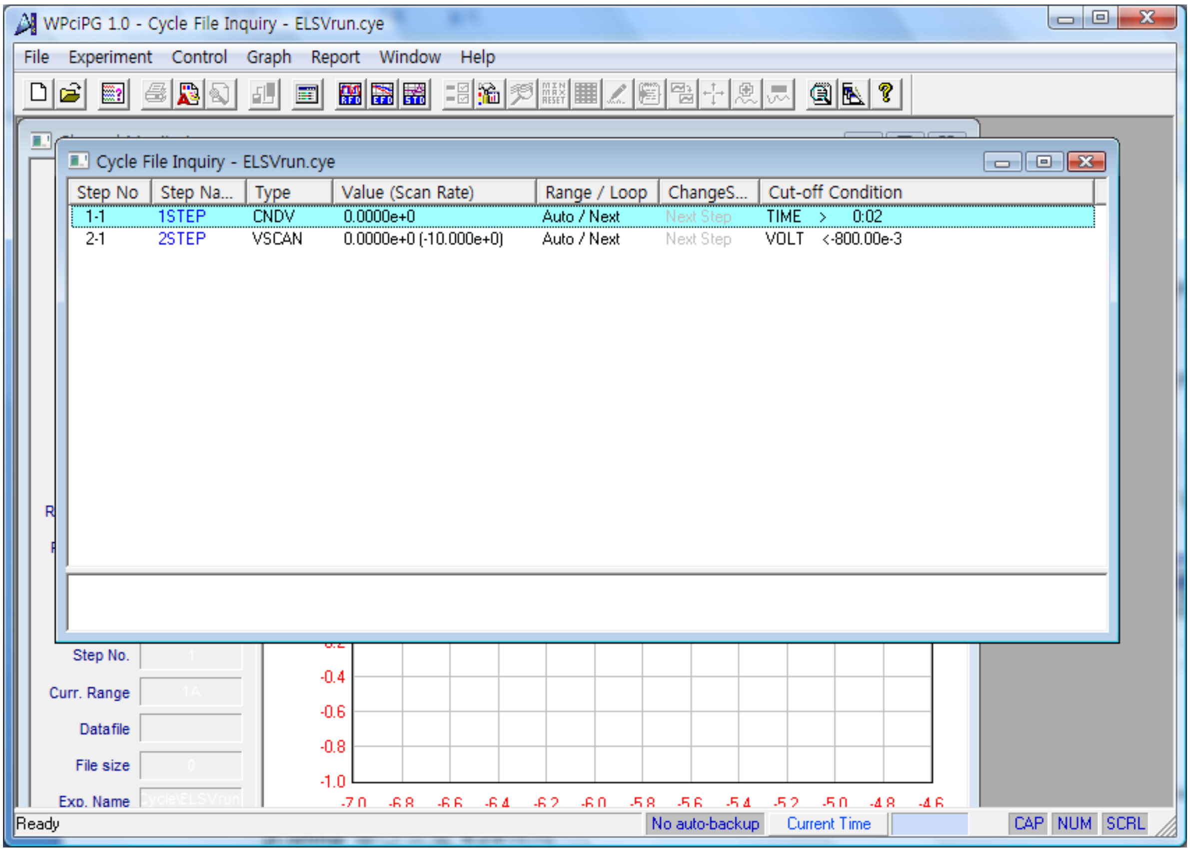
1. Select cycle condition file on cycle file combo box. You can move any folder, disk etc to load cycle condition file.

Each cycle condition file on combo box displays "C" or "E" mark. It distinguishes potentiostat mode and cycler mode. ("C" is for cycler mode and "E" is for potentiostat mode)
.

Caution
If you installed WPG software first time, the displayed cycle file was not assigned yet. Please select cycle file.

When you select cycle condition file, if you select cycler mode then the color will be green. If you select potentiostat mode then the color will be red. After these change, the voltage polarity is changed following each mode

If you want to see the charging/discharging procedure in selected cycle condition file, move mouse cursor on file name and click right mouse button then following window will be displayed.



2. If you bought Aux. option, select CalcV formula

   V3= V1+V2, V2-V1, V1-V2

   Aux. Option :

   The voltage (reading or applying) in 3 electrode system (working, reference, counter) is voltage difference value between working electrode and reference electrode. If user want to measure auxiliary voltage (such as working vs. Counter or counter vs. Reference, this option is needed.

3. If you system equipped temperature measurement option, You can measure temperature simultaneously.

4. Connect battery or half-cell to cell lead cable (working, reference, counter and sense terminal)

   If all connection is normal, you can see STBY (standby) in CH state column. The color will change to blue character in white background.

   If you tried to test dummy cell or cell itself has low potential at rest, you can see IDLE in status column.

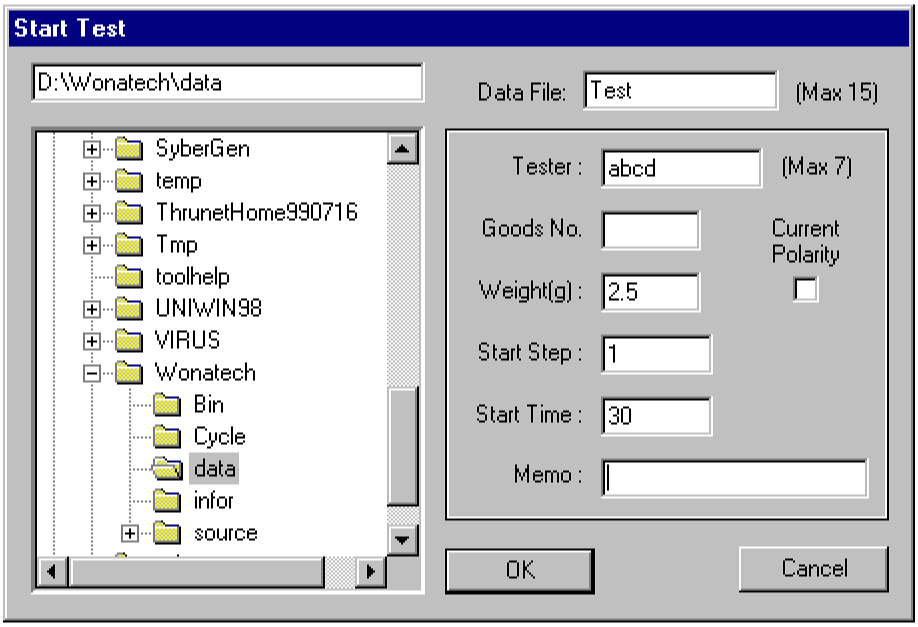
   With this condition if you press task bar to run experiment, warning window will appear to avoid mis-operation. If test cell has very low potential or dummy cell, press "O.K." button then the

experiment will start.

Warning:

Normal battery or half-cell has potential at rest. So if you connect cell or battery with potential and you found IDLE then you must check the cell connection again. If the reference electrode has vacancy in narrow part, it could make "IDLE: status.

5. Ready to run experiment



You can find the above window before you start experiment. In this window you can input the following information

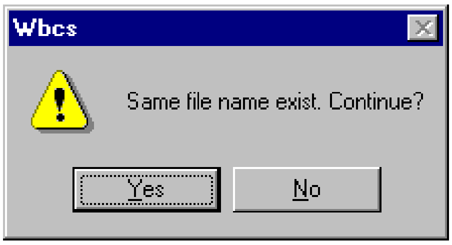
- Data file name: Max. 15character.

DO NOT use some registered characters as the followings
* | ₩ etc.

Name of tester: Max 6 characters
Goods No.: Max. 8 character
Weight: For calculation of specific capacity.

Start Step: The experiment will start from "start step"
Start Time: The experiment will start after "start time"
Memo field: (Scroll type)
Select folder which you want to save the data
If you finish to input information, then press "O.K." button

If there is same file name in specified folder, the following confirm message window will appear.



The experiment will start following step procedure in cycle file.

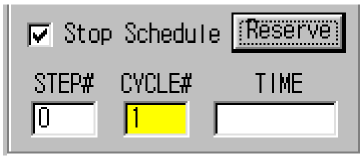
- Press buttons located in bottom side. There are start, pause (stop), suspend, change step function buttons.

  - Start: Start experiment
  - Pause: Experiment is stopped. Stopped experiment will be suspended later.
  - Suspend: It will continue experiment from stopped status. (The data will be added & updated to previous data).
  - Step change: If you want to change current step to specified step for selected running experiment, select step which you want to move

- Stop schedule

  If you want to stop running experiment by user's decision, It is possible to set stop schedule then the experiment will be stop when the setting condition is satisfied. The procedure is as the follows.

  - Press "Stop schedule" Button right bottom side



  - Select stop condition by check on Cycle number, Step number, running time and input condition.

  - Press "Reservation" button

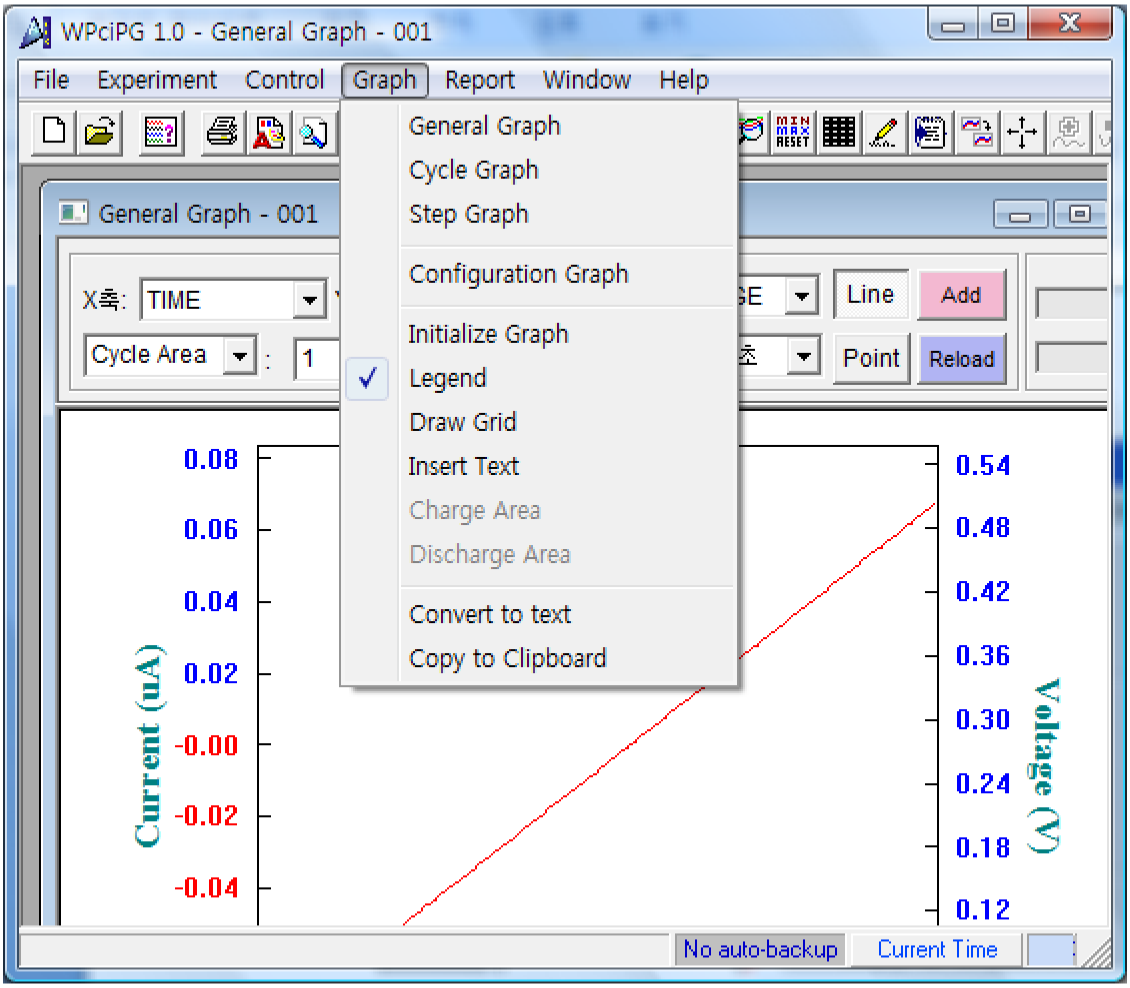
  You can see "stop schedule" status as right side on control panel

  If you want clear "stop schedule", press "stop schedule" button and check out the condition and press "reservation" button again.

  Without pressing reservation button, if you press "O.K" button then the condition, which you set up, will be not applied.

Tip: On stop schedule condition, cycle number and step number is AND logic, running time is OR logic.

Chapter 6. Graph Menu

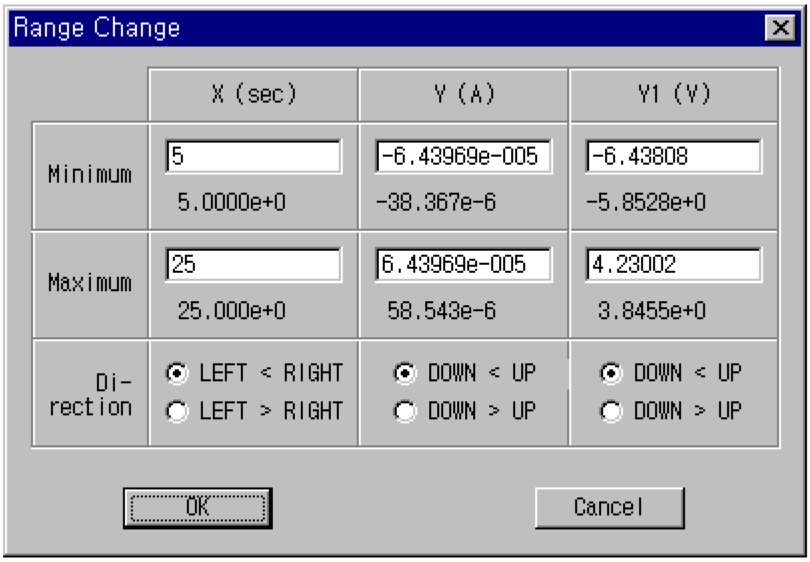


6-1 Basic Graph function

Following functions are effective on all kinds of graph format in WPG

6-1-1 User Scaling

- Graph's scale is automatic but if you want make a plot as you defined axis scale, press  in



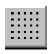
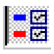
tool bar.

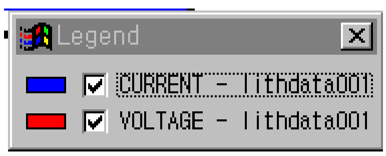
- The values below each input box means data's minimum and maximum value.
- If you want polarity direction of plot, You can change it by selecting direction and press O.K button. Then graph is re-plotted following setting value.

6-1-2 Zoom function

- In order to zoom up the graph area, move mouse cursor to left upper corner of target zoom area and hold down left button of mouse and drag it to right bottom corner of target zoom area and release mouse button. Then target area, which you made rectangular by mouse dragging, will be zoom up.
- If you want to return to original size, select "initialize graph" in graph menu or press  in tool bar

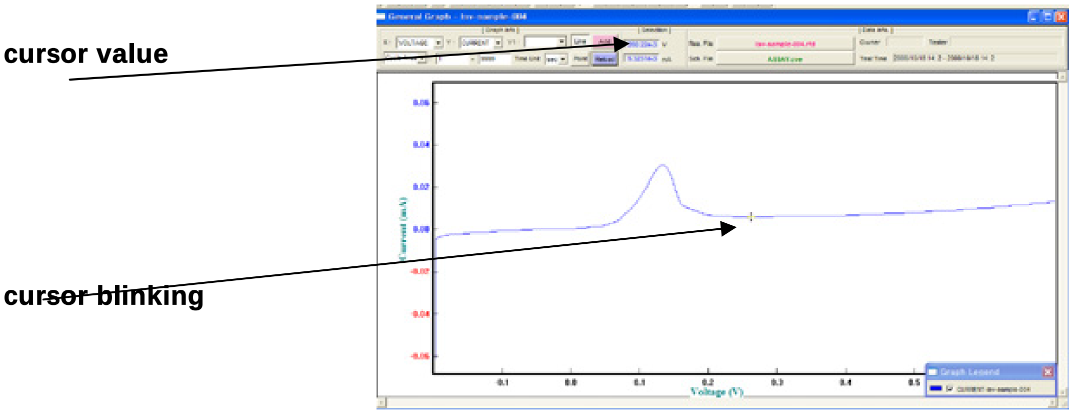
6-1-3 Grid on graph

- If you want to make grid on the graph, select "draw grid" or press  in tool bar
- Legend is on/off toggle operation. Press  in tool bar.
- When it off, it does not display.
- If you loaded multiple files, data color for same file is same color (Max. File number is 10)
- Right upper side of graph, you can find dot/line button. This toggle operation between line and dot display



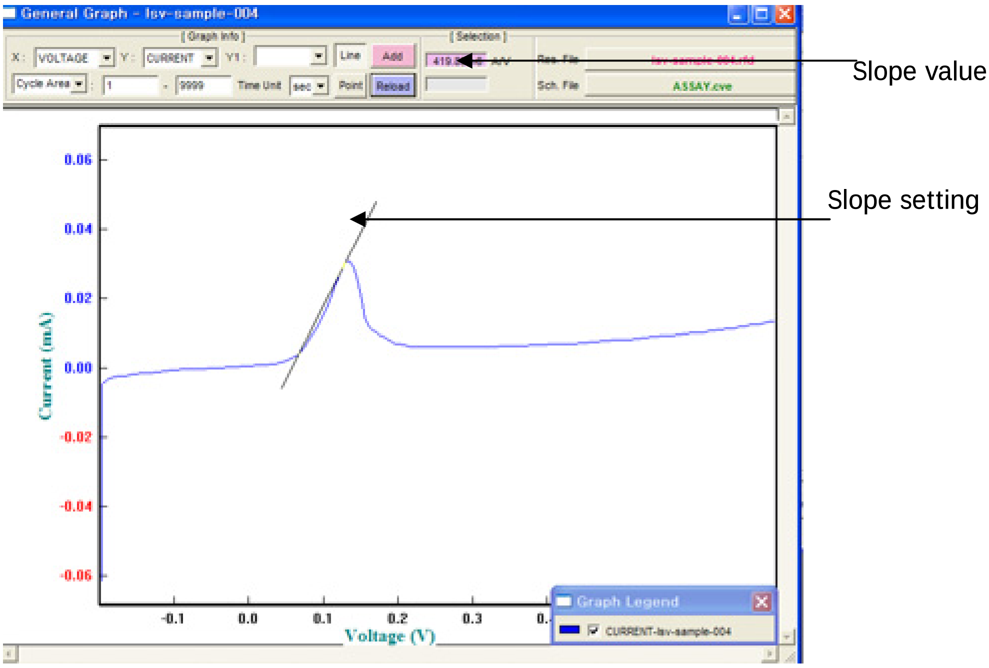
6-1-4 Coordinate value reading

- If you want coordinate value on the graph, move mouse cursor on where you want to know and double clicks left button of mouse, then you can see blinking cross-hair cursor nearest position by mouse cursor. The value displayed on right upper side. Left value means X-axis value and Right value means Y-axis value. The color left side from value means graph item(Y or Y1 axis)
- You can move cross-hair cursor by pressing <-(left) or ->(right) arrow key on keyboard then cross-hair cursor moves following graph value.
- If you want to see another value(Y or Y1 axis), press upside or downside arrow key then the color is changed by item
- If you want to make disable cross-hair cursor, press cross –hair icon on tool bar.

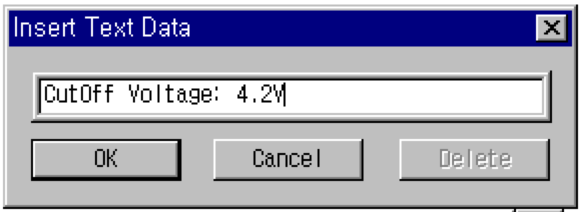


6-1-5 Slope calculation:

- If you want to get slope value on graph (To get Tafel constant etc.), Move mouse cursor to start point and hold down right button of mouse and drag it to target point and release right button then you can get slope value on right upper side of window. If you find two values, It means you drew Y and Y1 axis. One is for Y and the other is for Y1.



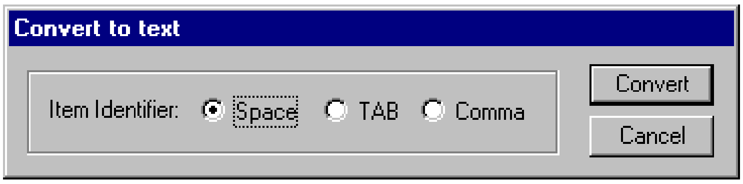
6-1-6 Text Insertion



- If you want to insert some text on the graph, press icon  on tool bar
- Then above dialog box appear. Type text and press O.K. button
- You can find the text which you input on left upper side of graph
- Move mouse cursor on the text and press mouse left button and drag it to location where you want
- If you want to move the text to another place, then drag it to new location
- If you want to modify or delete the text on the graph which you input, move mouse cursor on the text and double click mouse left button then you will find above dialog box. You can modify the text or "delete" button to delete it.

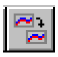
6-1-7 ASCII conversion

- If you want to convert X, Y (Y1) data of graph, press "Convert" on tool bar then.

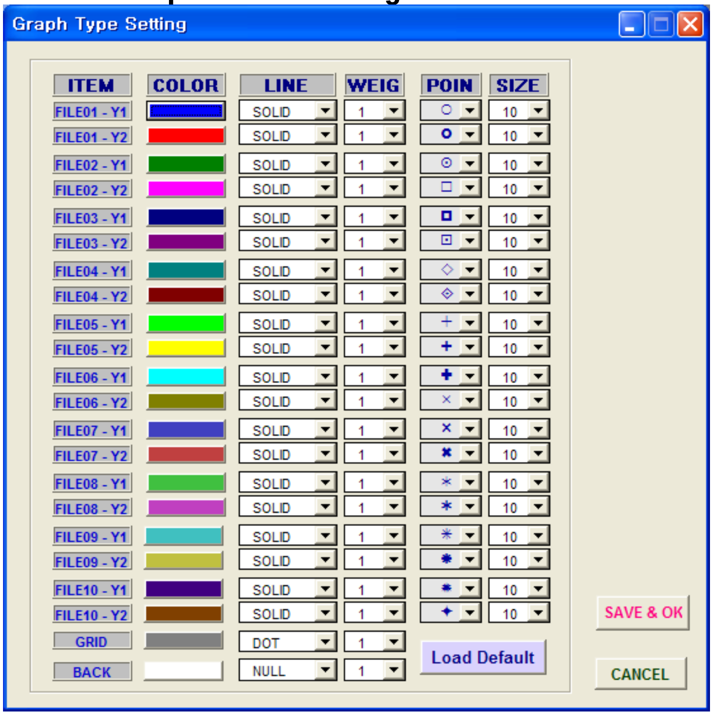


- Tip: Text file conversion in file menu converts all item or selected item to ASCII file.

6-1-8 Copy to Clipboard

- Copy to clipboard: If you want to use graph in other application program, copy graph to clipboard by pressing  on tool bar.

6-1-9. Graph format setting



6-2. General data Graph

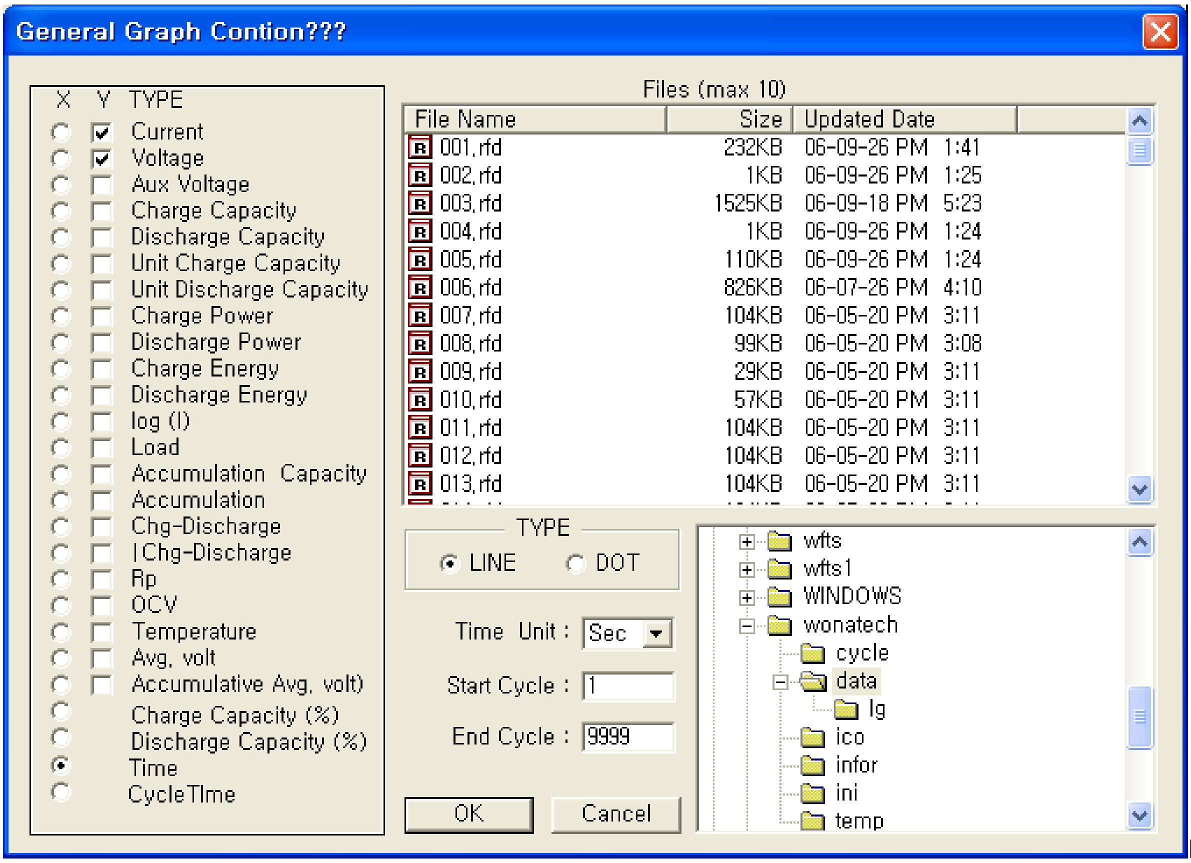
This is basic graph format for battery testing and electrochemical testing.

Select general graph in graph menu or press  RFD icon in tool bar.

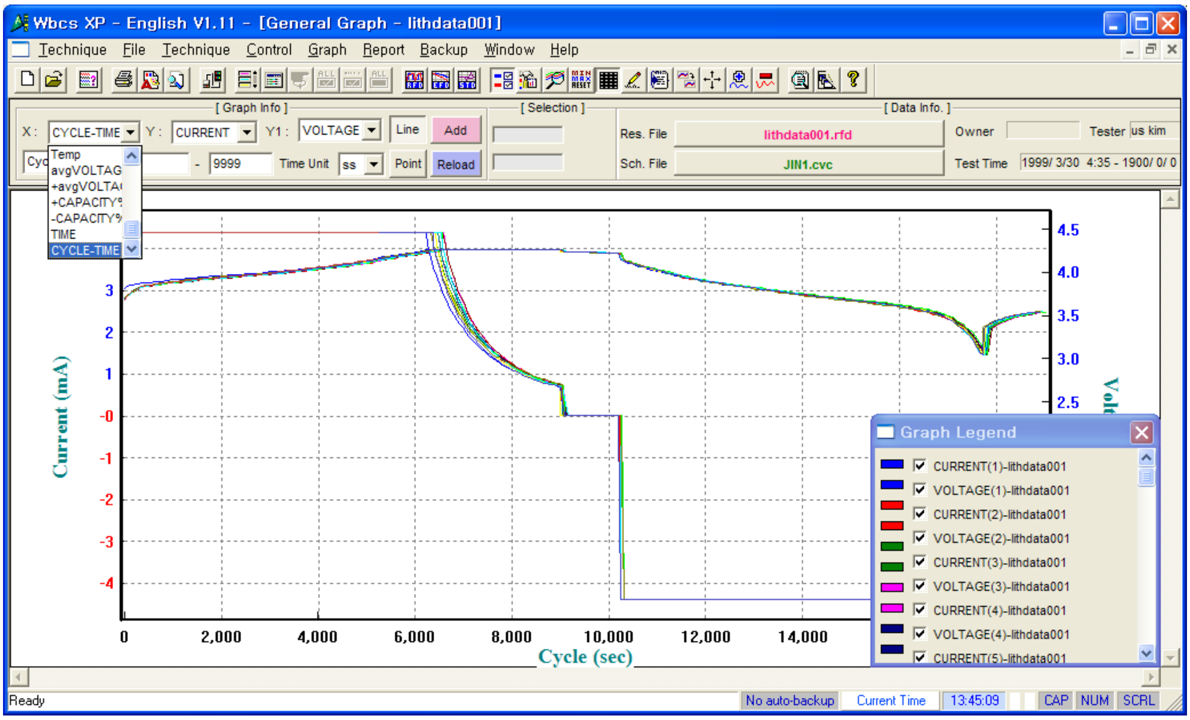
- Choose folder that contains data file, which you want to plot.
- Select file(s) to be for plot
- Maximum files for overlay is 10 files. You can drag mouse cursor on area to select files or press ctrl + mouse clicking on each file.
- Select axis parameter
- Select time unit
- Select line or dot
- Select cycle numbers to plot graph.
- Note: time unit & cycle numbers can not be changed after loading data.

6-2-1 Axis parameters

- X-axis: time, cycle time, current, voltage, auxV, charging capacity, discharging capacity, specific charging capacity, specific discharging capacity, charging power, discharging power, charging energy, discharging energy, LogI, Load, Summed capacity, Absolute summed capacity, overall capacity, absolute overall capacity, temperature
- Y, Y1 axis: current, voltage, auxV, charging capacity, discharging capacity, specific charging capacity, specific discharging capacity, charging power, discharging power, charging energy, discharging energy, LogI, Load, Summed capacity, Absolute summed capacity, overall capacity, absolute overall capacity, temperature
- Specific capacity is capacity divided by battery weight when you input in start window.



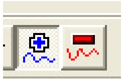
Press O.K button then WPG plot graph



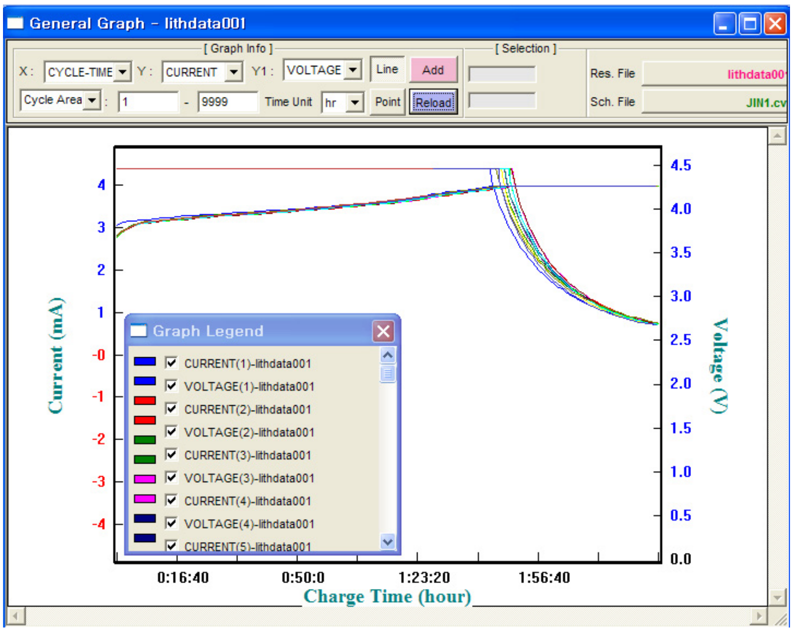
- After plot graph, if you want to change axis parameters, Simple select the parameter in combo box for each axis located in upper side and press "RELOAD" button
- If you want to see the graph for data of running channel, Pressing "RELOAD" button makes a plot as updated.

6-2-2 Special Plots on general data graph

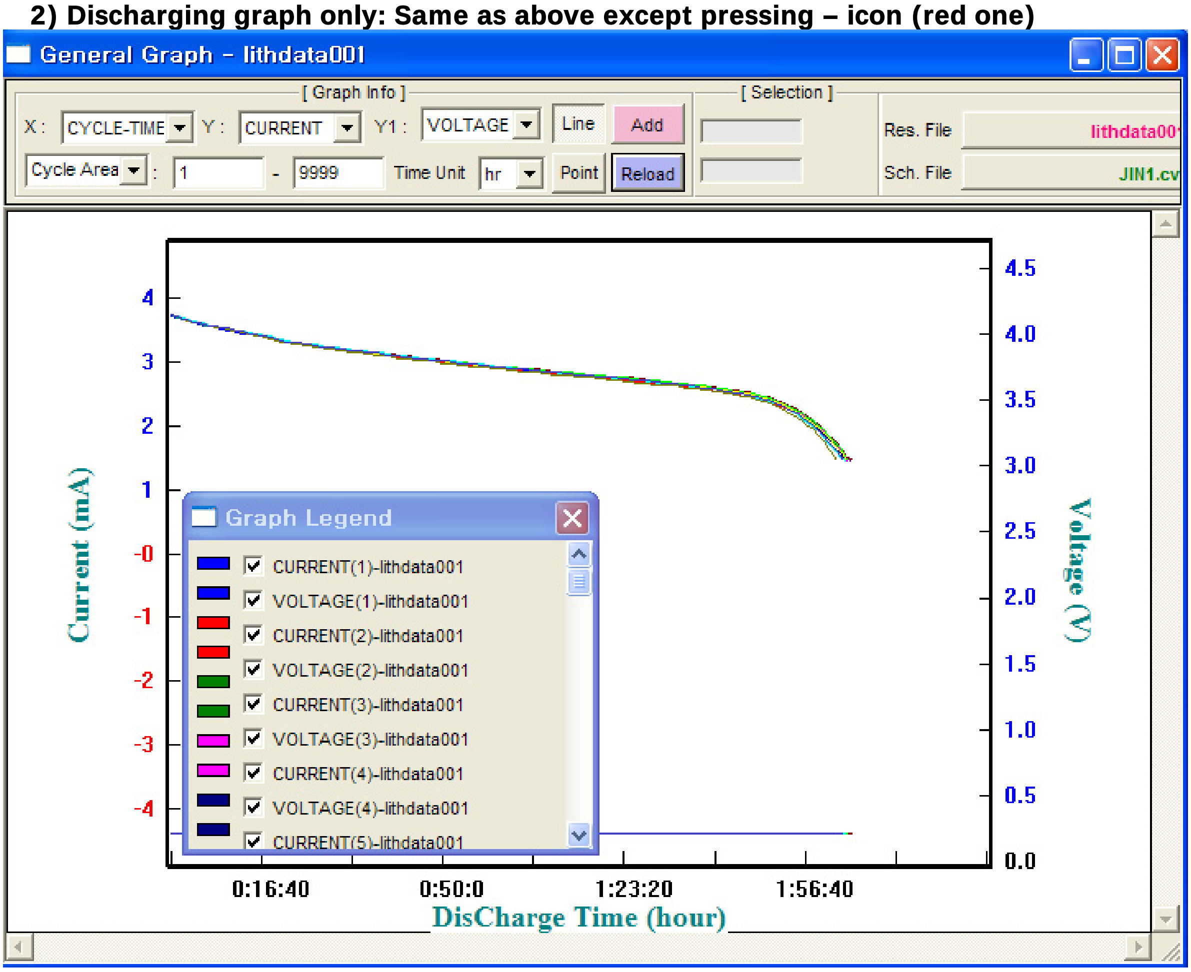
1) Charging Graph only

Set x axis as "cycle-time" and press + icon  .

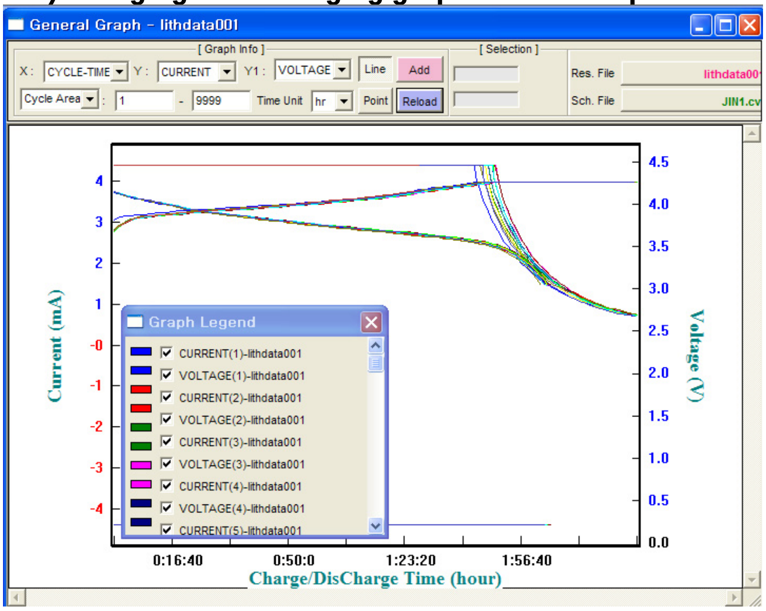
This will change X axis from cycle time to charging time.



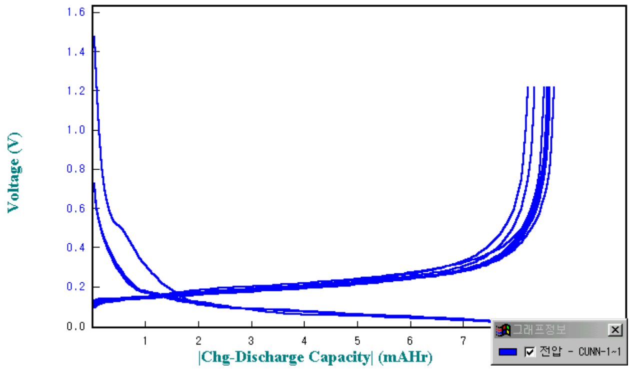
2) Discharging graph only: Same as above except pressing – icon (red one)



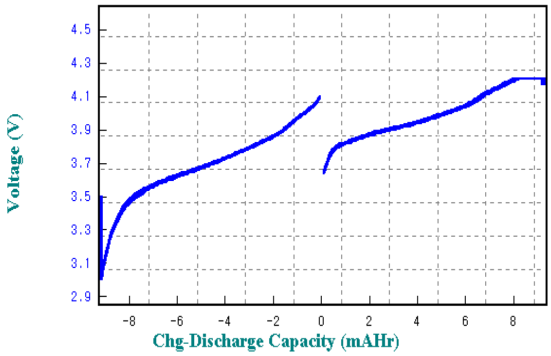
3) Charging & Discharging graph: + & - icon pressed.



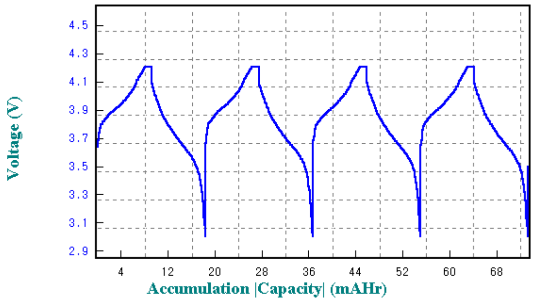
4) Example



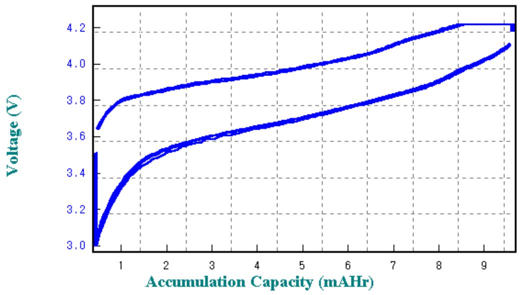
voltage vs. |charge/discharge capacity|



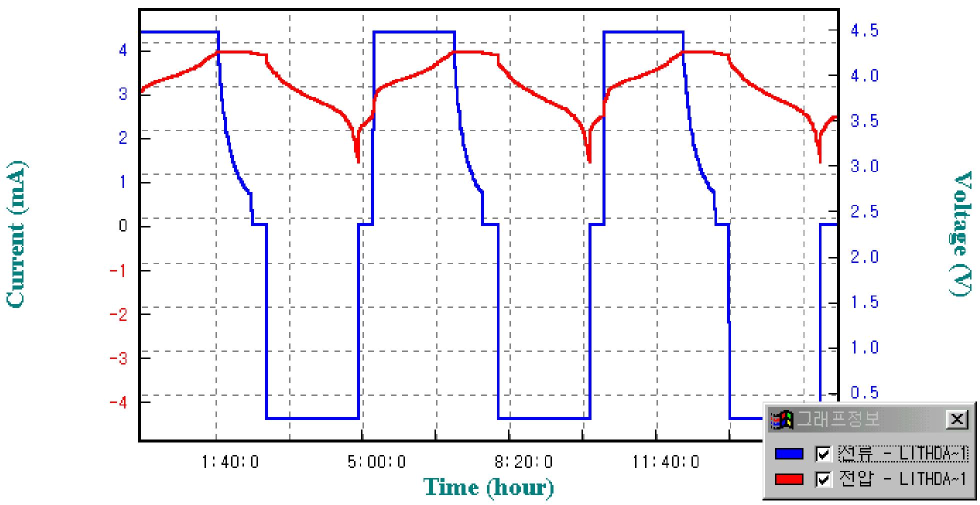
voltage vs. charge/discharge cap



voltage vs. abs. cap



voltage vs. accum cap

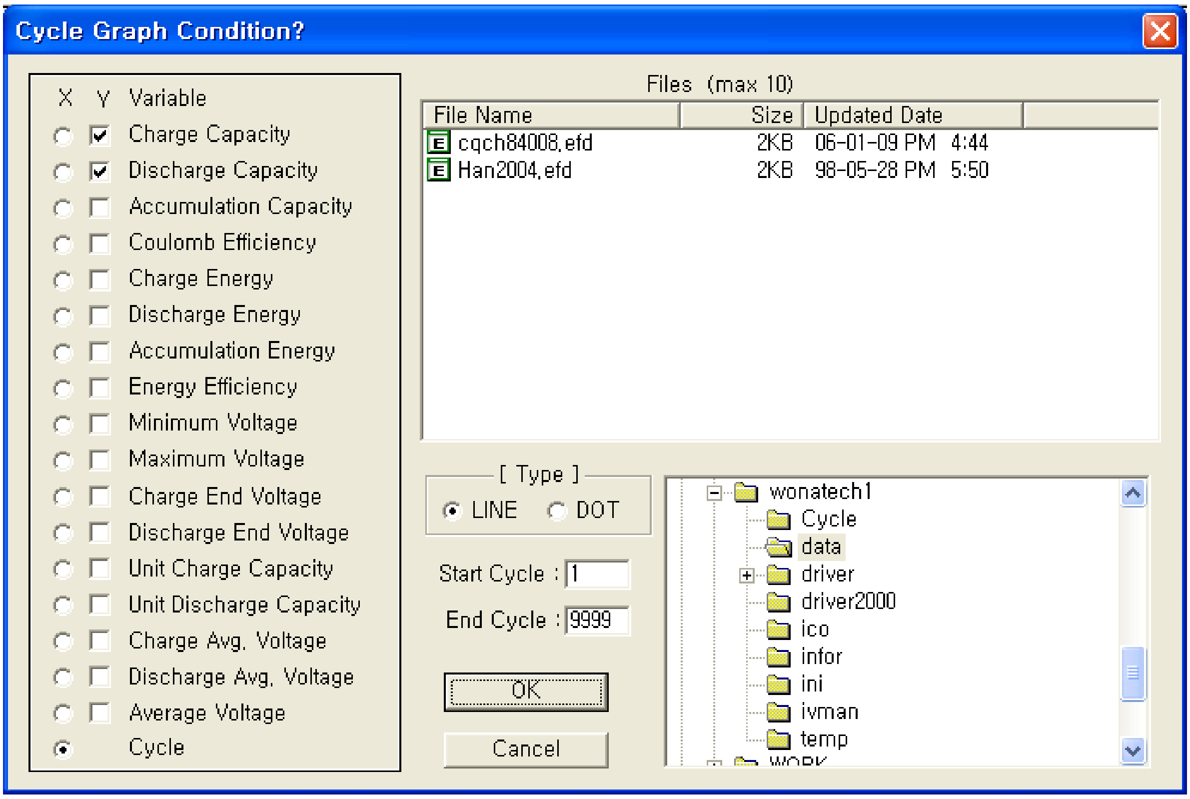


6-3 Cycle data Graph

Select cycle graph on graph menu or click  EFD icon on tool bar, then

6-3-1 Axis parameters

- X axis: cycle number, charging capacity, discharging capacity, summed capacity, Coulomb efficiency, charging energy, discharging energy. Summed energy, energy efficiency, minimum voltage, Maximum voltage, Charging end voltage, discharging end voltage
- Y, Y1 axis: charging capacity, discharging capacity, summed capacity, Coulomb efficiency, charging energy, discharging energy. Summed energy, energy efficiency, minimum voltage, Maximum voltage, Charging end voltage, discharging end voltage
- Y axis is maximum 2
- If you want to load multiple files, maximum file number is 10
- You can select point or line
- Extra function is same as general data graph.

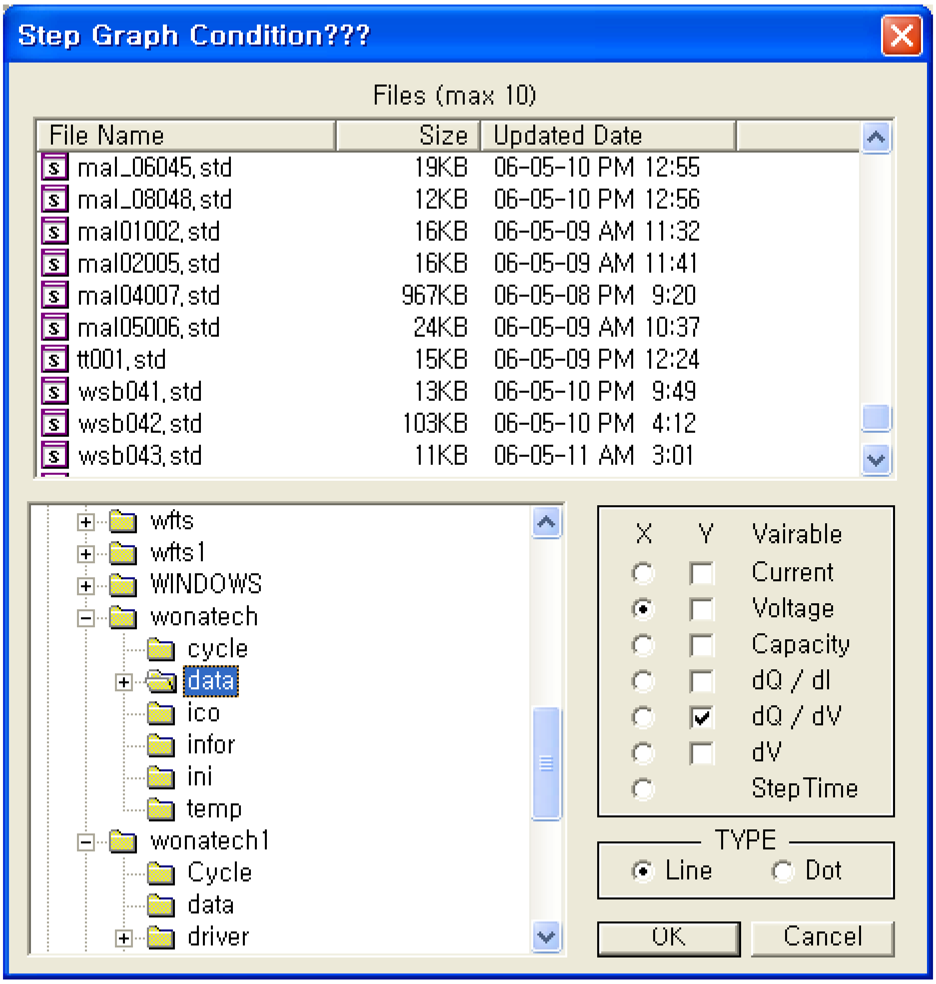


6-4 Step Data Graph

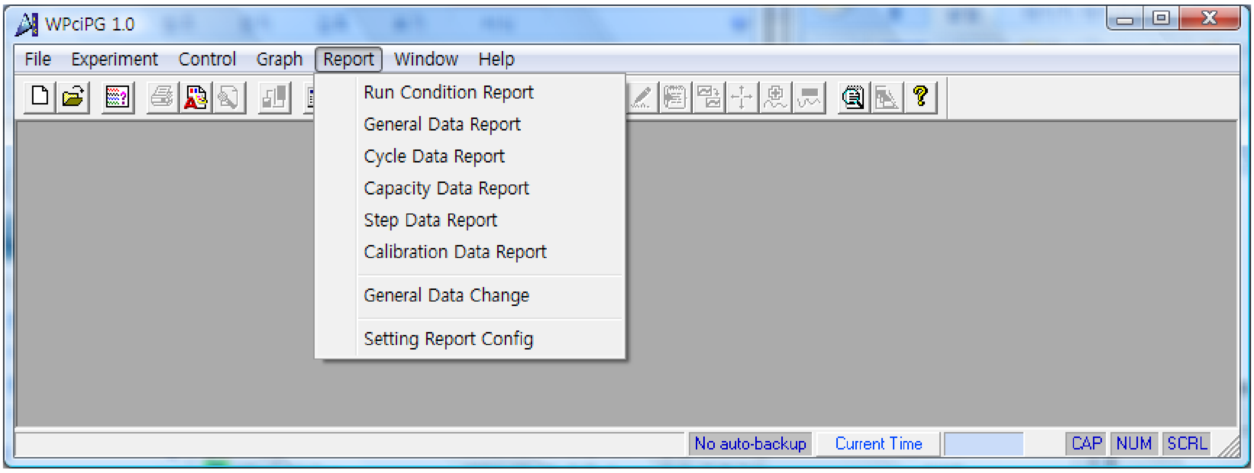
Step data graph is for Electrochemical voltage spectroscopy but you can use it for other purpose.

Select step graph on graph menu or click  STD icon on tool bar then

- X axis: current,voltage,capacity,dQ/dV, dQ/dI, dV, step time
- Y,Y1 axis: current, voltage, capacity, dQ/dV, dQ/dI, dV
- Y axis is maximum 2
- If you want to load multiple files, maximum file number is 10
- You can select point or line
- Extra function is same as general data graph.

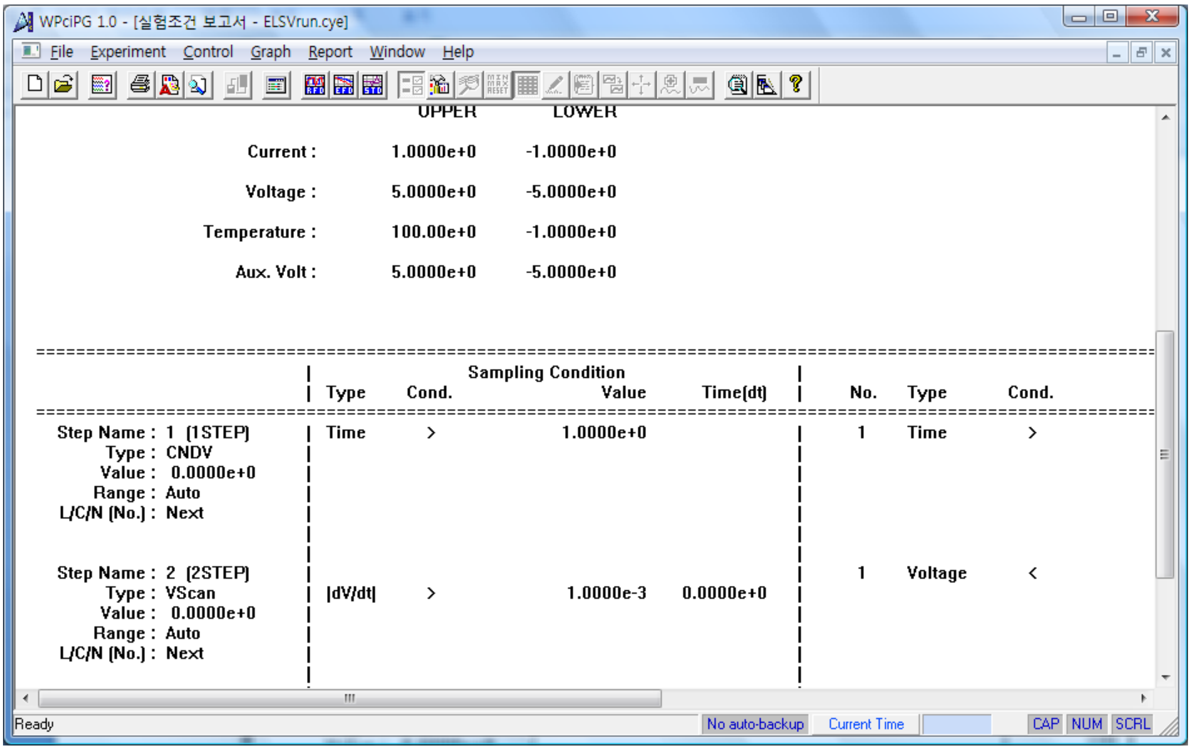


Chapter 7. Report

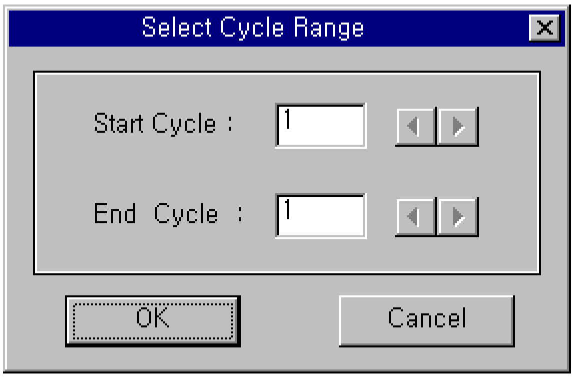


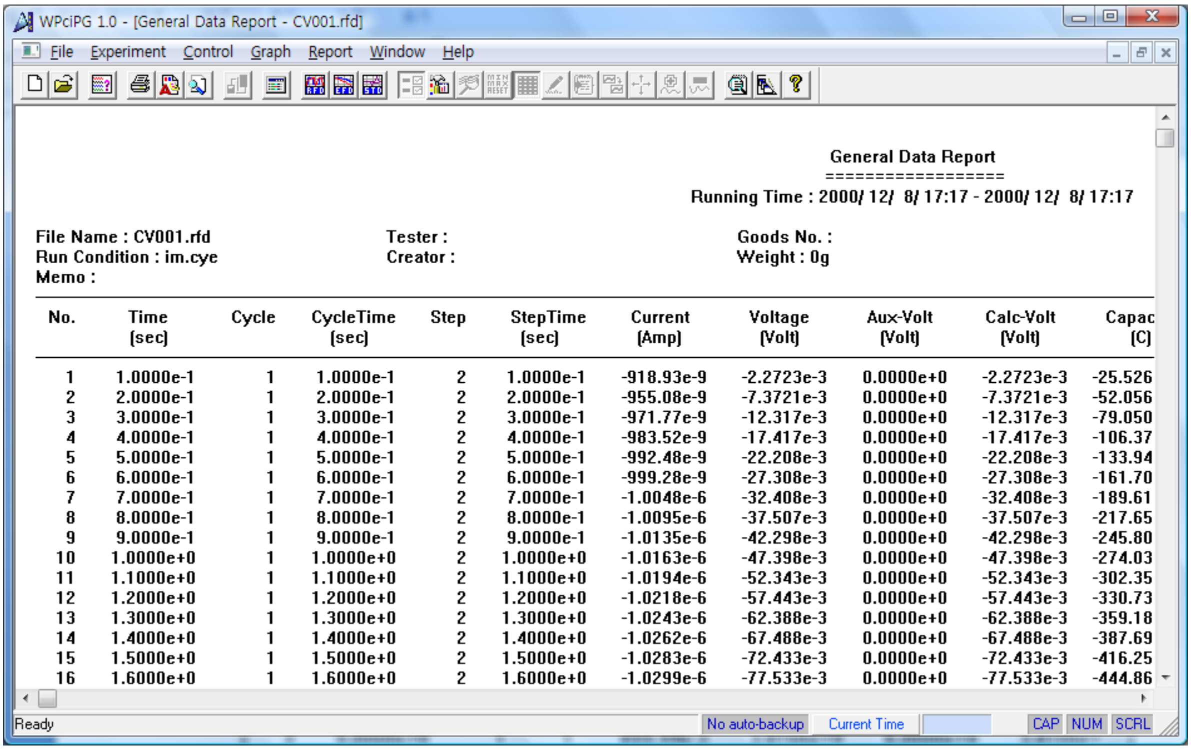
7-1. Cycle Condition file report

Open cycle file from source folder.



Open general data file (extension: rfd) in source folder (Default c:₩WonATech ₩data) and select cycle range to report.





General Data Report

Running Time : 2000/ 12/ 8/ 17:17 - 2000/ 12/ 8/ 17:17

File Name : CV001.rfd
Run Condition : im.cye
Memo :

Tester :
Creator :

Goods No. :
Weight : 0g

No.	Time (sec)	Cycle	CycleTime (sec)	Step	StepTime (sec)	Current (Amp)	Voltage (Volt)	Aux-Volt (Volt)	Calc-Volt (Volt)	Capac (C)
1	1.0000e-1	1	1.0000e-1	2	1.0000e-1	-918.93e-9	-2.2723e-3	0.0000e+0	-2.2723e-3	-25.526
2	2.0000e-1	1	2.0000e-1	2	2.0000e-1	-955.08e-9	-7.3721e-3	0.0000e+0	-7.3721e-3	-52.056
3	3.0000e-1	1	3.0000e-1	2	3.0000e-1	-971.77e-9	-12.317e-3	0.0000e+0	-12.317e-3	-79.050
4	4.0000e-1	1	4.0000e-1	2	4.0000e-1	-983.52e-9	-17.417e-3	0.0000e+0	-17.417e-3	-106.37
5	5.0000e-1	1	5.0000e-1	2	5.0000e-1	-992.48e-9	-22.208e-3	0.0000e+0	-22.208e-3	-133.94
6	6.0000e-1	1	6.0000e-1	2	6.0000e-1	-999.28e-9	-27.308e-3	0.0000e+0	-27.308e-3	-161.70
7	7.0000e-1	1	7.0000e-1	2	7.0000e-1	-1.0048e-6	-32.408e-3	0.0000e+0	-32.408e-3	-189.61
8	8.0000e-1	1	8.0000e-1	2	8.0000e-1	-1.0095e-6	-37.507e-3	0.0000e+0	-37.507e-3	-217.65
9	9.0000e-1	1	9.0000e-1	2	9.0000e-1	-1.0135e-6	-42.298e-3	0.0000e+0	-42.298e-3	-245.80
10	1.0000e+0	1	1.0000e+0	2	1.0000e+0	-1.0163e-6	-47.398e-3	0.0000e+0	-47.398e-3	-274.03
11	1.1000e+0	1	1.1000e+0	2	1.1000e+0	-1.0194e-6	-52.343e-3	0.0000e+0	-52.343e-3	-302.35
12	1.2000e+0	1	1.2000e+0	2	1.2000e+0	-1.0218e-6	-57.443e-3	0.0000e+0	-57.443e-3	-330.73
13	1.3000e+0	1	1.3000e+0	2	1.3000e+0	-1.0243e-6	-62.388e-3	0.0000e+0	-62.388e-3	-359.18
14	1.4000e+0	1	1.4000e+0	2	1.4000e+0	-1.0262e-6	-67.488e-3	0.0000e+0	-67.488e-3	-387.69
15	1.5000e+0	1	1.5000e+0	2	1.5000e+0	-1.0283e-6	-72.433e-3	0.0000e+0	-72.433e-3	-416.25
16	1.6000e+0	1	1.6000e+0	2	1.6000e+0	-1.0299e-6	-77.533e-3	0.0000e+0	-77.533e-3	-444.86

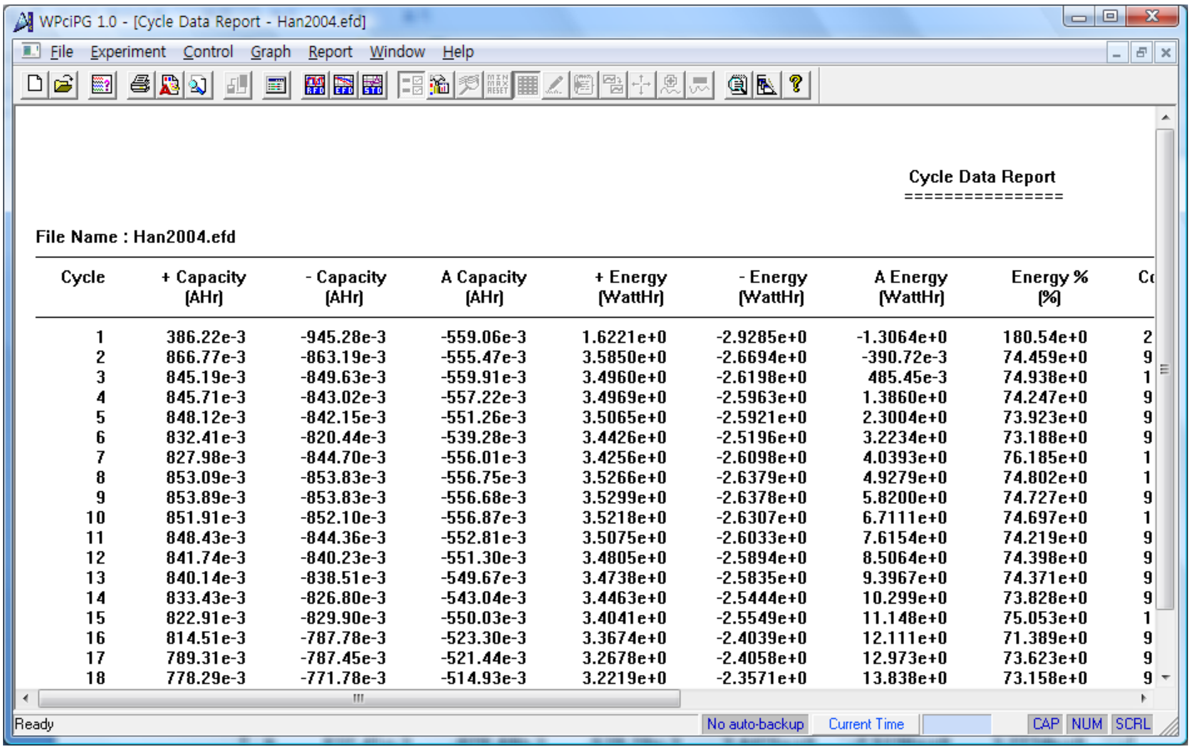
- Time duration (Start time & Stop time) is reported automatically. Stop time is not end time. If you did suspend the experiment, then stop time is different from end time.
- If you see 0000/00/00 00:00 at stop time, It means that this data file is on running now.

- This report automatically describes data file name, cycle file name, cycle file creator name, tester name, goods No., battery weight.

7-2. Cycle Data Report

Open cycle data file (extension: efd) in source folder (Default c:₩WonATech ₩data) and select cycle range to report. If you see the following window, It means that there is no cycling.



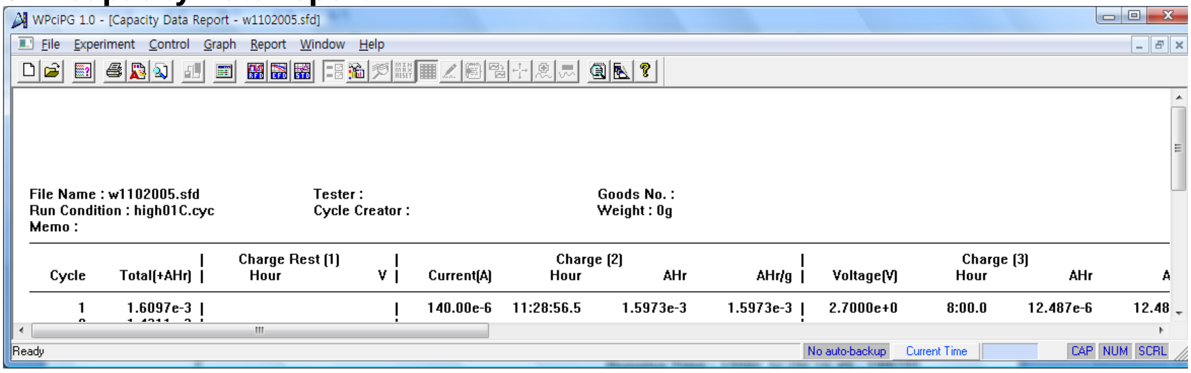


Cycle Data Report
================

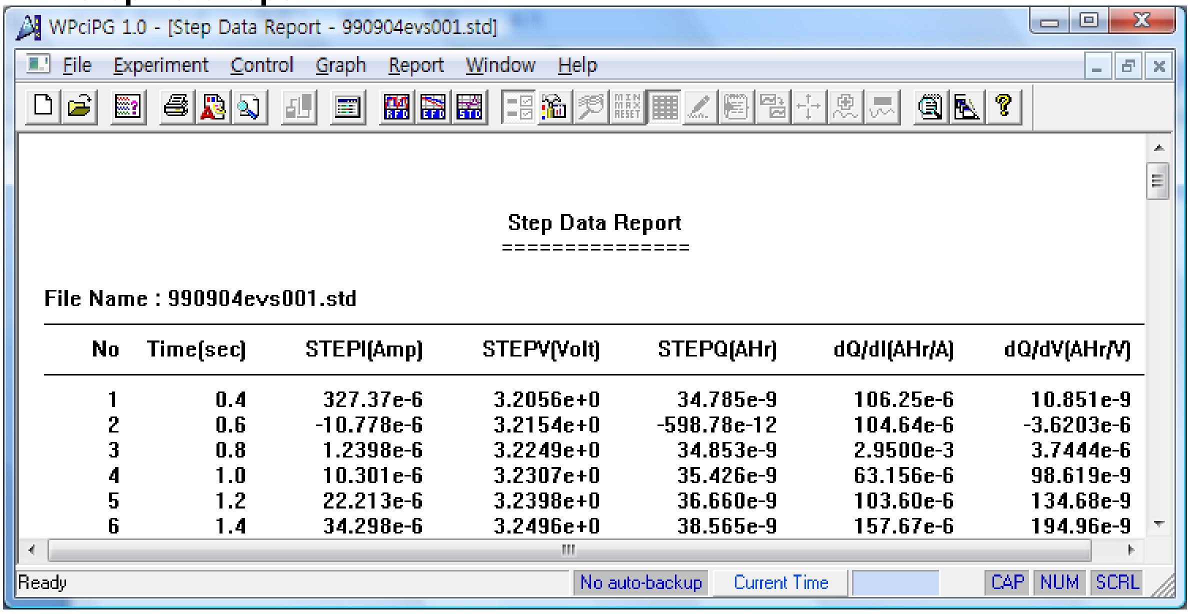
File Name : Han2004.efd

Cycle	+ Capacity (AHr)	- Capacity (AHr)	A Capacity (AHr)	+ Energy (WattHr)	- Energy (WattHr)	A Energy (WattHr)	Energy % (%)	Cc
1	386.22e-3	-945.28e-3	-559.06e-3	1.6221e+0	-2.9285e+0	-1.3064e+0	180.54e+0	2
2	866.77e-3	-863.19e-3	-555.47e-3	3.5850e+0	-2.6694e+0	-390.72e-3	74.459e+0	9
3	845.19e-3	-849.63e-3	-559.91e-3	3.4960e+0	-2.6198e+0	485.45e-3	74.938e+0	1
4	845.71e-3	-843.02e-3	-557.22e-3	3.4969e+0	-2.5963e+0	1.3860e+0	74.247e+0	9
5	848.12e-3	-842.15e-3	-551.26e-3	3.5065e+0	-2.5921e+0	2.3004e+0	73.923e+0	9
6	832.41e-3	-820.44e-3	-539.28e-3	3.4426e+0	-2.5196e+0	3.2234e+0	73.188e+0	9
7	827.98e-3	-844.70e-3	-556.01e-3	3.4256e+0	-2.6098e+0	4.0393e+0	76.185e+0	1
8	853.09e-3	-853.83e-3	-556.75e-3	3.5266e+0	-2.6379e+0	4.9279e+0	74.802e+0	1
9	853.89e-3	-853.83e-3	-556.68e-3	3.5299e+0	-2.6378e+0	5.8200e+0	74.727e+0	9
10	851.91e-3	-852.10e-3	-556.87e-3	3.5218e+0	-2.6307e+0	6.7111e+0	74.697e+0	1
11	848.43e-3	-844.36e-3	-552.81e-3	3.5075e+0	-2.6033e+0	7.6154e+0	74.219e+0	9
12	841.74e-3	-840.23e-3	-551.30e-3	3.4805e+0	-2.5894e+0	8.5064e+0	74.398e+0	9
13	840.14e-3	-838.51e-3	-549.67e-3	3.4738e+0	-2.5835e+0	9.3967e+0	74.371e+0	9
14	833.43e-3	-826.80e-3	-543.04e-3	3.4463e+0	-2.5444e+0	10.299e+0	73.828e+0	9
15	822.91e-3	-829.90e-3	-550.03e-3	3.4041e+0	-2.5549e+0	11.148e+0	75.053e+0	1
16	814.51e-3	-787.78e-3	-523.30e-3	3.3674e+0	-2.4039e+0	12.111e+0	71.389e+0	9
17	789.31e-3	-787.45e-3	-521.44e-3	3.2678e+0	-2.4058e+0	12.973e+0	73.623e+0	9
18	778.29e-3	-771.78e-3	-514.93e-3	3.2219e+0	-2.3571e+0	13.838e+0	73.158e+0	9

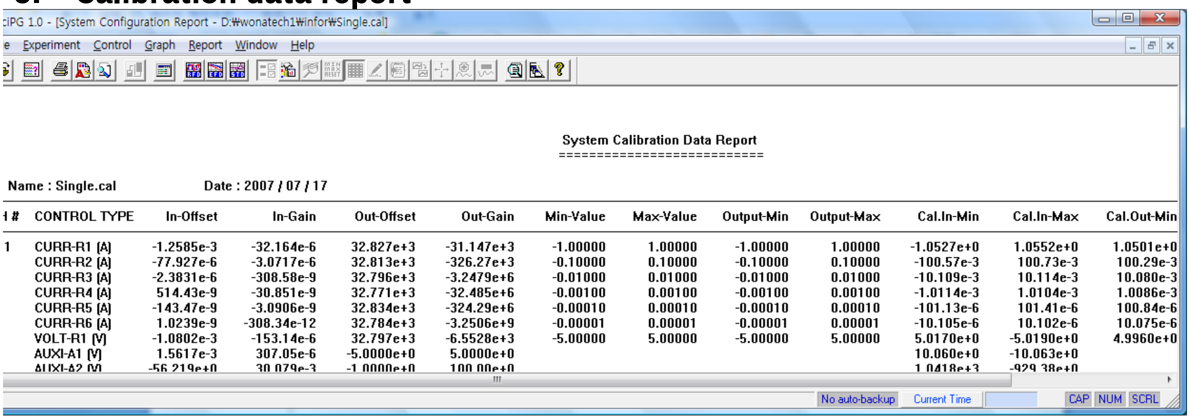
7-3. Capacity Data report



7-4. Step Data report



7-5. Calibration data report



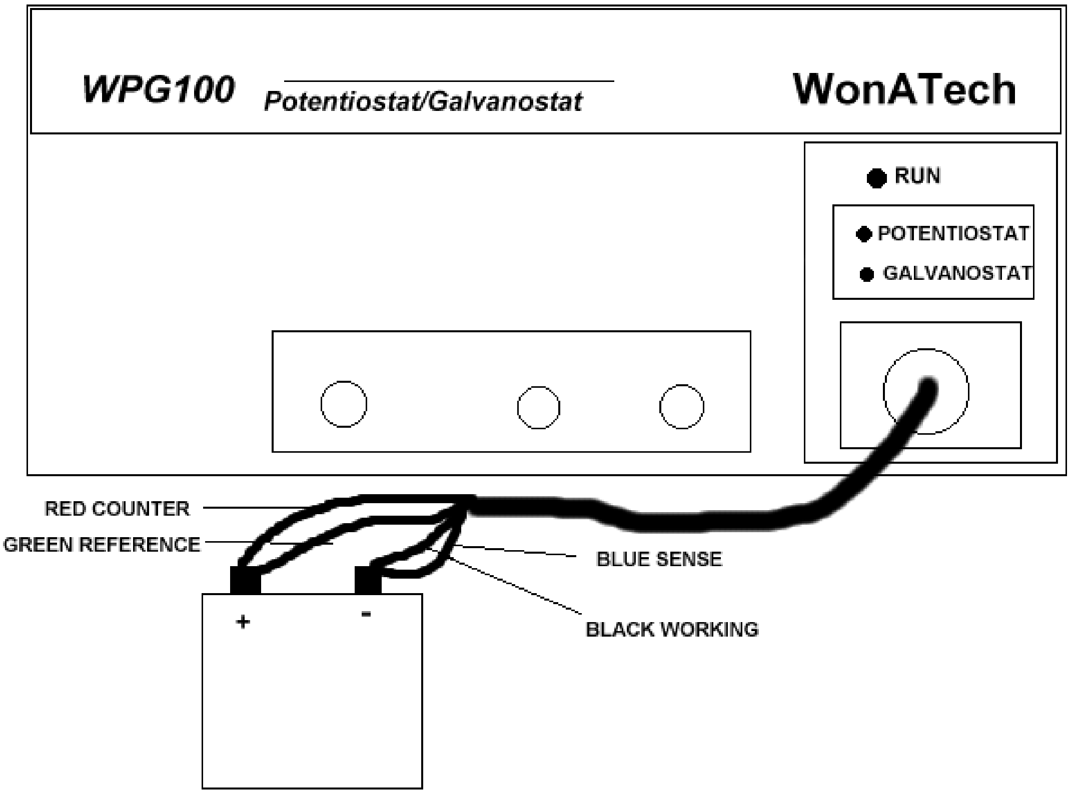
APPENDIX

Appendix 1. Cell Connection

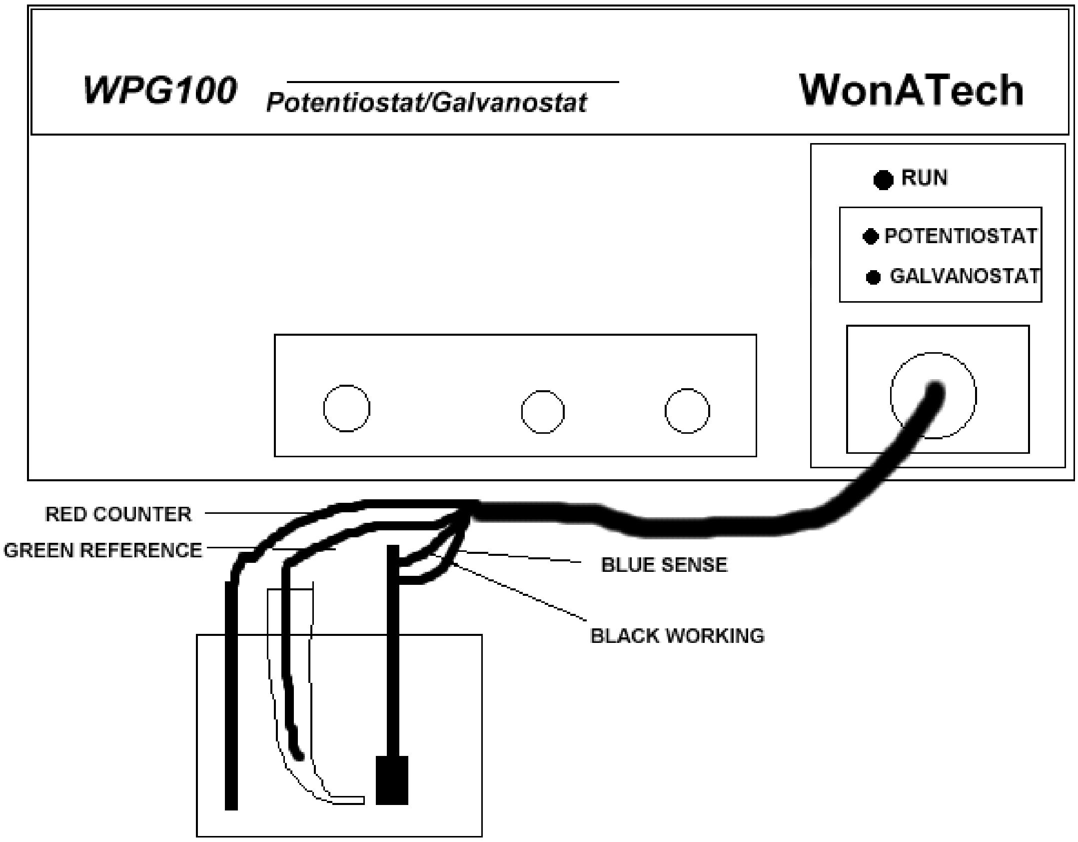
☞ Electrode Cable Color

Working Electrode = BLACK
Counter Electrode = RED
Reference Electrode = GREEN
Sense Electrode = WHITE

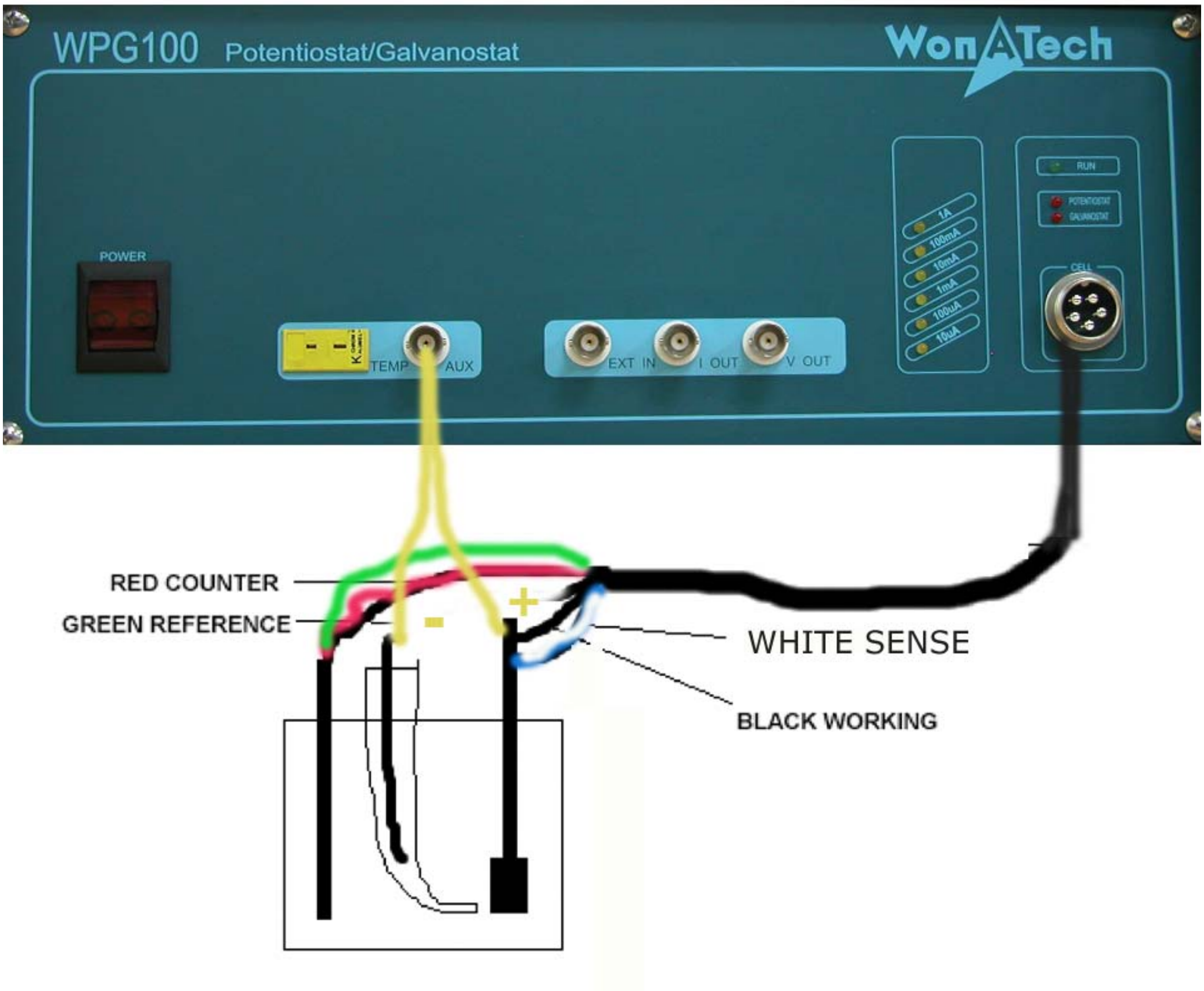
A1-1 Battery Test



A1-2 Electrochemistry experiment and half cell test



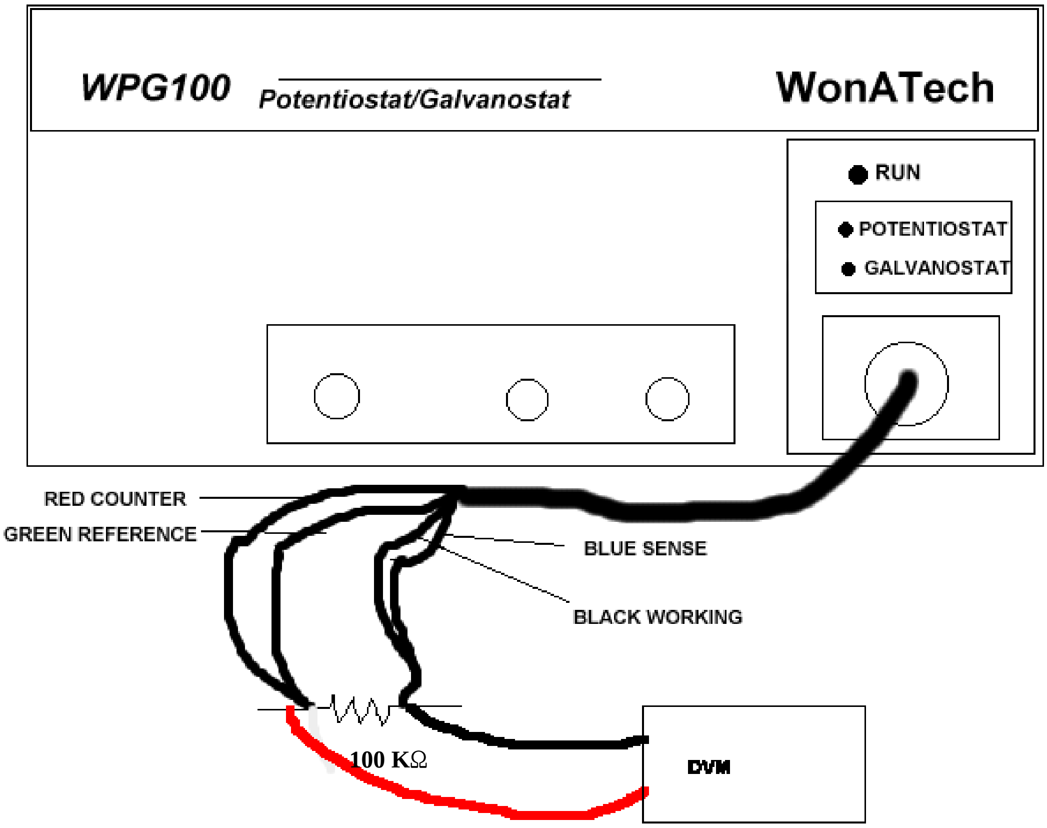
A1-3. Galvanic corrosion test



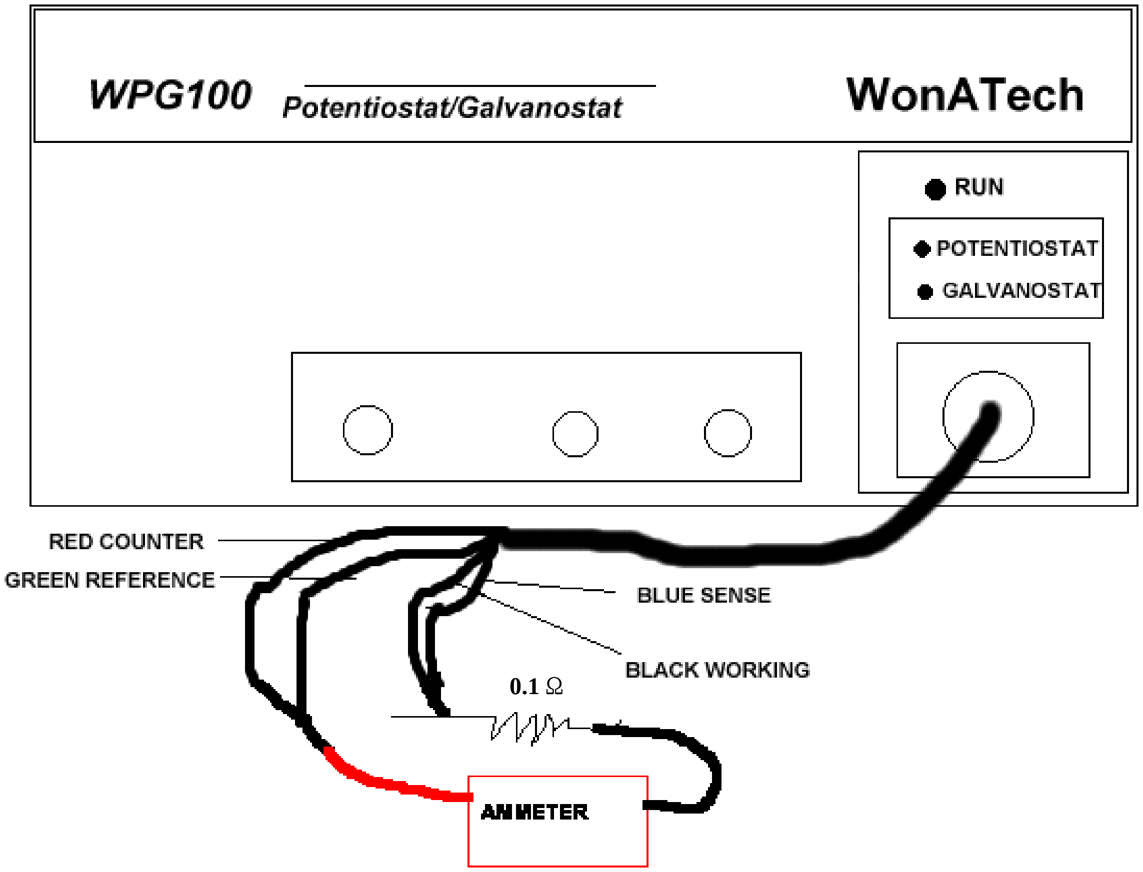
Appendix 2. Calibration

A2-1 Using external resistor

A2-1-1 Voltage calibration



A2-1-2 Current calibration



A2-2 Using simple calibration kit(option)



- connect cell cable connector as the follows

calibrator(label)	cell cable
sense	working sense lead
working	working electrode lead

reference	reference electrode lead
counter	counter(auxiliary electrode) lead

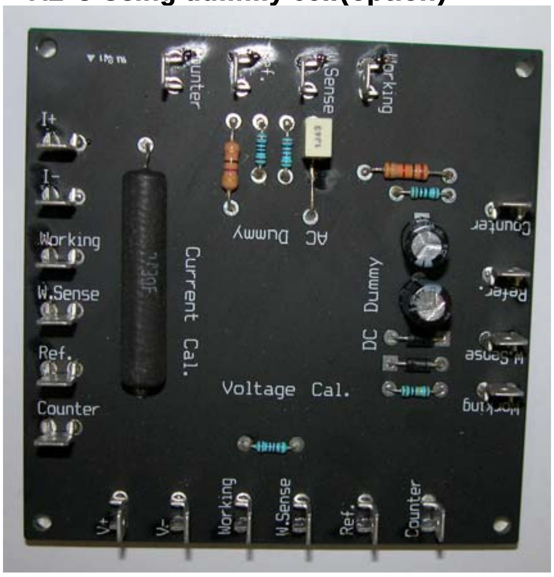
A2-2-1 voltage calibration

1. set toggle switch on calibration to "V CALIB"
2. set voltmeter(multimeter) for DC voltage measurement
3. connect red cable from voltmeter to "+" on calibrator and black cable from voltmeter to "-" on calibrator

A2-2-2 current calibration

4. 1. set toggle switch on calibration to "I CALIB"
5. set ammeter(multimeter) for DC current measurement
6. connect red cable from ammeter to "+" on calibrator and black cable from ammeter to "-" on calibrator

A2-3 Using dummy cell(option)



- connect cell cable connector as the follows

W.sense	working sense lead
working	working electrode lead
Ref	reference electrode lead
counter	counter(auxiliary electrode) lead
V+	V+ terminal of voltmeter
V-	V- terminal of voltmeter
I+	I+ terminal of ammeter
I-	I- terminal of ammeter

A2-3-1 voltage calibration

1. Connect the cables from potentiostat to each terminals at "Voltage Cal"
2. set voltmeter(multimeter) for DC voltage measurement
3. connect red cable from voltmeter to "V+" on dummy cell and black cable from voltmeter to "-" on dummy cell

A2-3-2 current calibration

4. Connect the cables from potentiostat to each terminals at "Current Cal"
5. set ammeter(multimeter) for DC current measurement
6. connect red cable from ammeter to "I+" on dummy cell and black cable from ammeter to "I-" on dummy cell

A2-4. Calibration program; xcalib.exe

- **Check earth ground**
- **Check connection of resistor & voltmeter(Ammeter) correctly**

Execute xcalib.exe in WonATech folder, then you can see warning message window. This warning message is for protection from novice's calibration trial. (You can calibrate unused channel when WPGpci_eng.exe is used)

Tip: If you executed wcalib.exe without loading xpciserver.exe or XUSBserver.exe, You can not load xpciserver.exe or XUSBserver.exe

1) Select channel number which you want to calibrate(1)
2) Select Calib type(Refer to the above guide how to connect resistor connection)
3) Select level1
4) Input desired output value in output value box(Note: Unit is based on the unit which is located in upper row than level1

Tip) Select the value for level1,2,3,4, as 90%, 30%, -30%, -90% of full range value

e.g.) +/-5Volt case: +4.5V,+1.5V, -1.5V, -4.5V

5) Check the connection between WPG, resistor and multimeter again
6) Press Calib. Start button then run LED is lighting and you can hear Relay's tick sound. Read the multimeter value and input this value in "Actual value" box

If run LED is not lighting or multimeter's reading value is so far from output value which you input, then check the above procedure 1 to 5 .If you fail to find why this problem came, please contact to our service department.

7) Press Calib End button.
8) Select Level 2
9) Repeat the above procedure 4)-7)
10) After finish level4, check "RATE" (The are located right bottom side). They should be near by 100 value. If those rates are far from 100 or red color, please check whether input actual value is correct or not.
11) Press apply button then calibration data is updated.
12) Input middle value of full range value on TEST value box and press "GO" button. Check Result value and multimeter value. They (Result value & Multimeter value) should be within +/-0.1% of full range value from TEST input value. If any of result (result value or multimeter value) is far from expected, then re-calibrate again.
13) If you use WPGpci_eng.exe to run other channels, then you must press "UPLOAD" button to use calibrated data.
14) Save calibration file in file menu.
15) Repeat the procedure from 2) as same manner for other calib type.

- Tip

a) Unit: For current calibration, use unit for output value. (e.g. Input 30 for 30uA if the unit is uA,

Input 0.08 for 80mA if the unit is A)

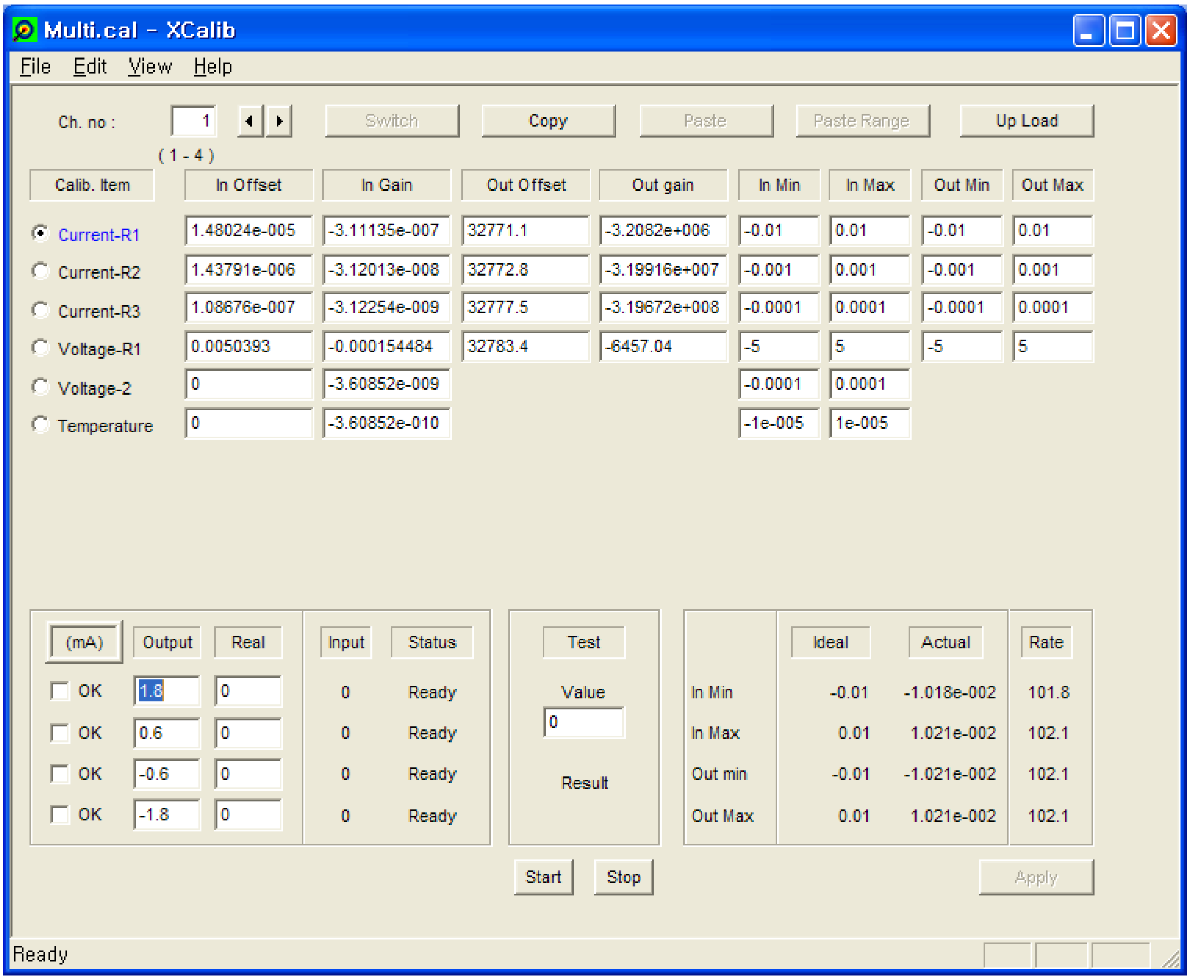
b) If you try to calibrate running channel, you can see the following error message.



c) If you try to TEST to check whether calibration is successful or not, the unit for input value is same as the unit for calibration.

d) Caution.

- Select Resistor value using formula E=IR, I=E/R under system specification.
- On calibration, WPGpci_eng.exe displays status for calibration channel as CALIB and you can not use this channel for experiment.



Appendix 3. Tool Bar



1. Create New experiment condition file
2. Open experiment condition file
3. View experiment condition file
4. Print
5. Print configuration
6. Preview Print out
7. Calibration
8. Activate virtual control panel
9. General data graph

A . Cycle data graph

B. Step data graph

C. LEGAND ON/OFF

D. Graph configuration

E. Initiate zooming

F. Manual scaling of graph

G. Grid On/OFF

H. Insert text on graph

I. Convert ASCII file from graph value(x,y,y1)

J. Copy to clipboard

K. Hide cross-hair cursor

L. View charging graph only

M. View discharging graph only

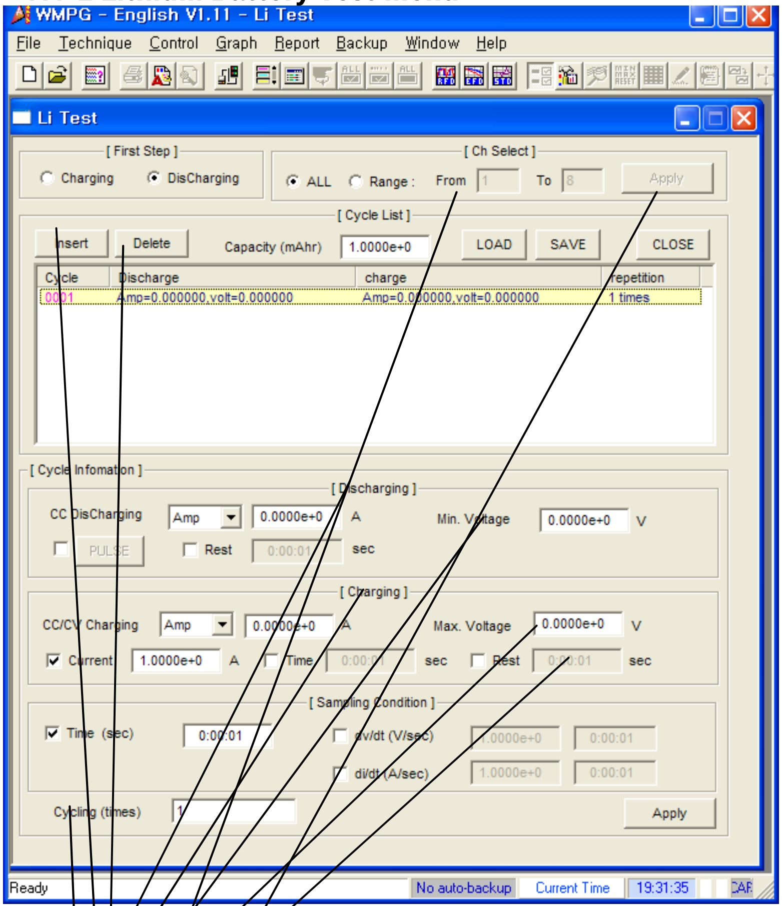
N. View spread sheet data

O. Close opened windows

P. Program information

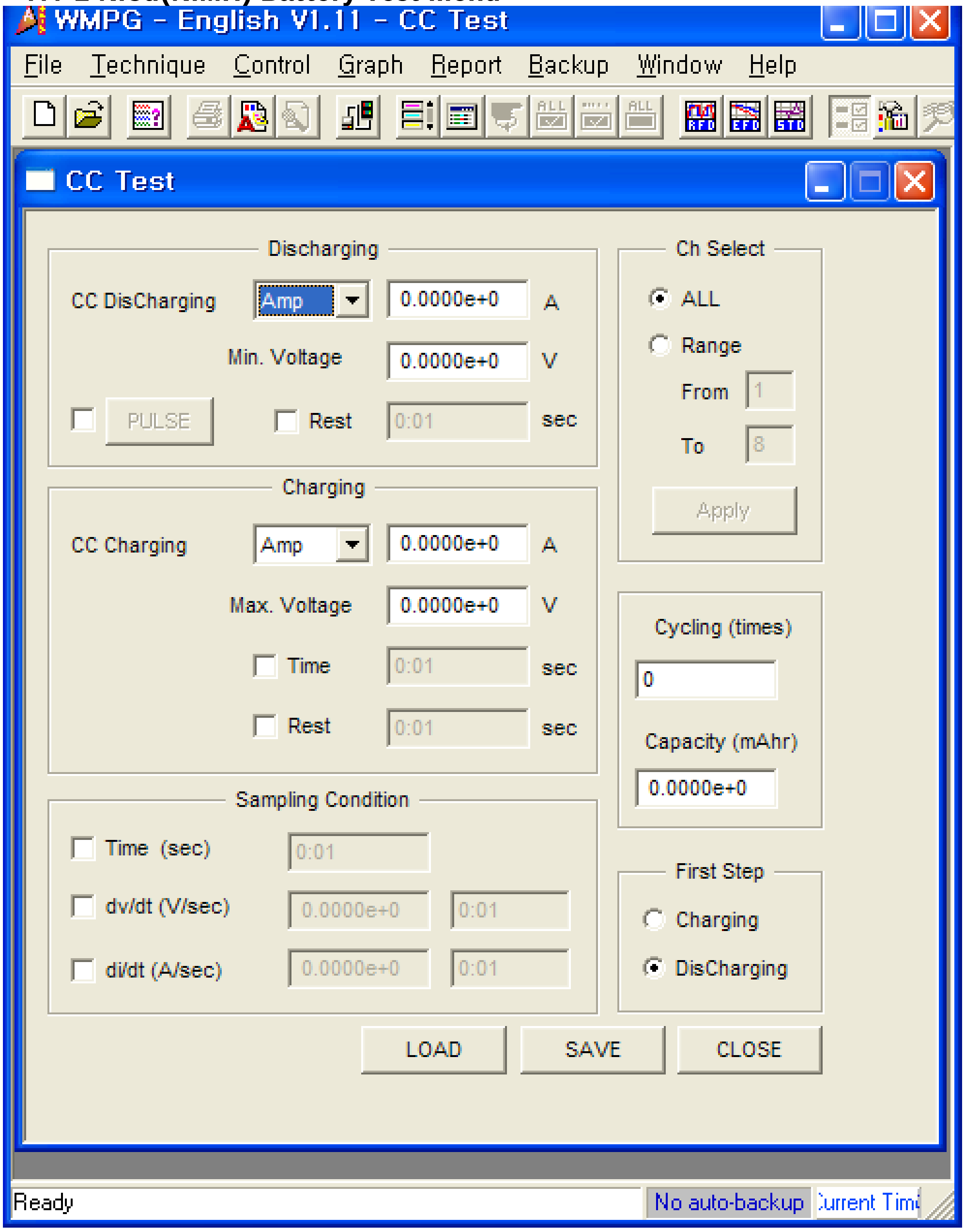
Appendix 4. Battery test menu-Option

A4-1 Lithium Battery Test menu



- Select Starting step: Charging or Discharging
- You can append the cycling type by pressing "insert" button
- At each step, you can select discharging/ charging parameters.
- Cutoff condition of each
- Rest select
- Cycling time select
- Select channels which you apply this test condition
- Press "apply" button in order to assign this test condition to channels

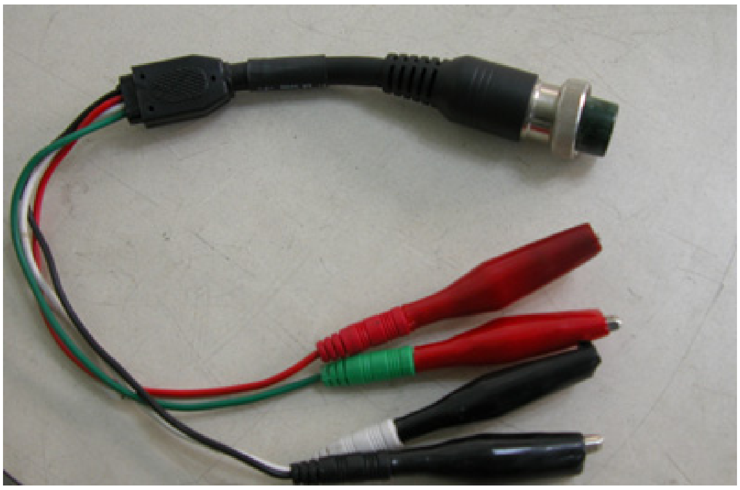
A4-2 NiCd(NiMH) Battery Test menu



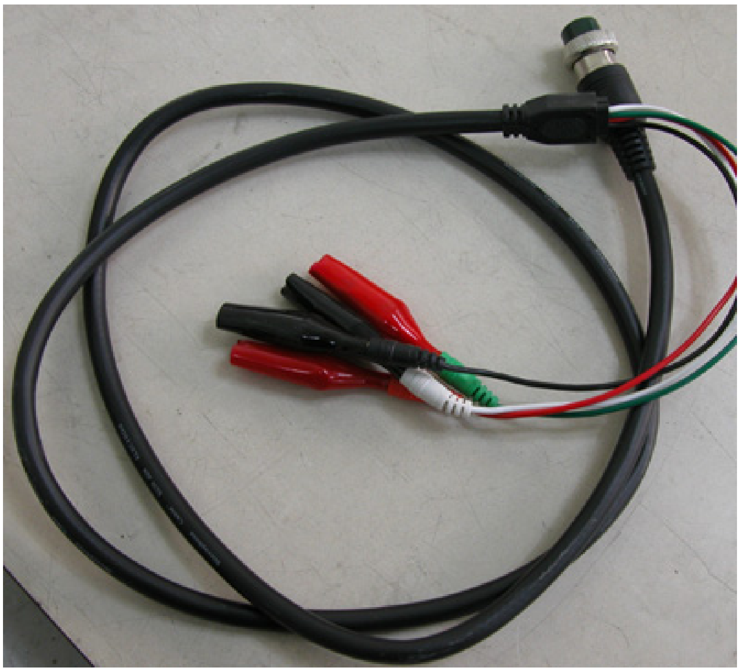
Refer to the Li battery test menu

Appendix 5. cable & card

A5-1. Cell cable



Short cable



1.5 meters cable

4 probes alligator clip terminal cable: working, sense, reference, counter

A5-2. Interface cable



A5-3. Interface card



◆ Reset Switch

■ LED Blinking: Resetting process

● LED On: Communication with PC

Note: When you met memory failure message at server program, please press the reset button. (If your system is USB version, you can find reset button near by USB connector located on rear panel)